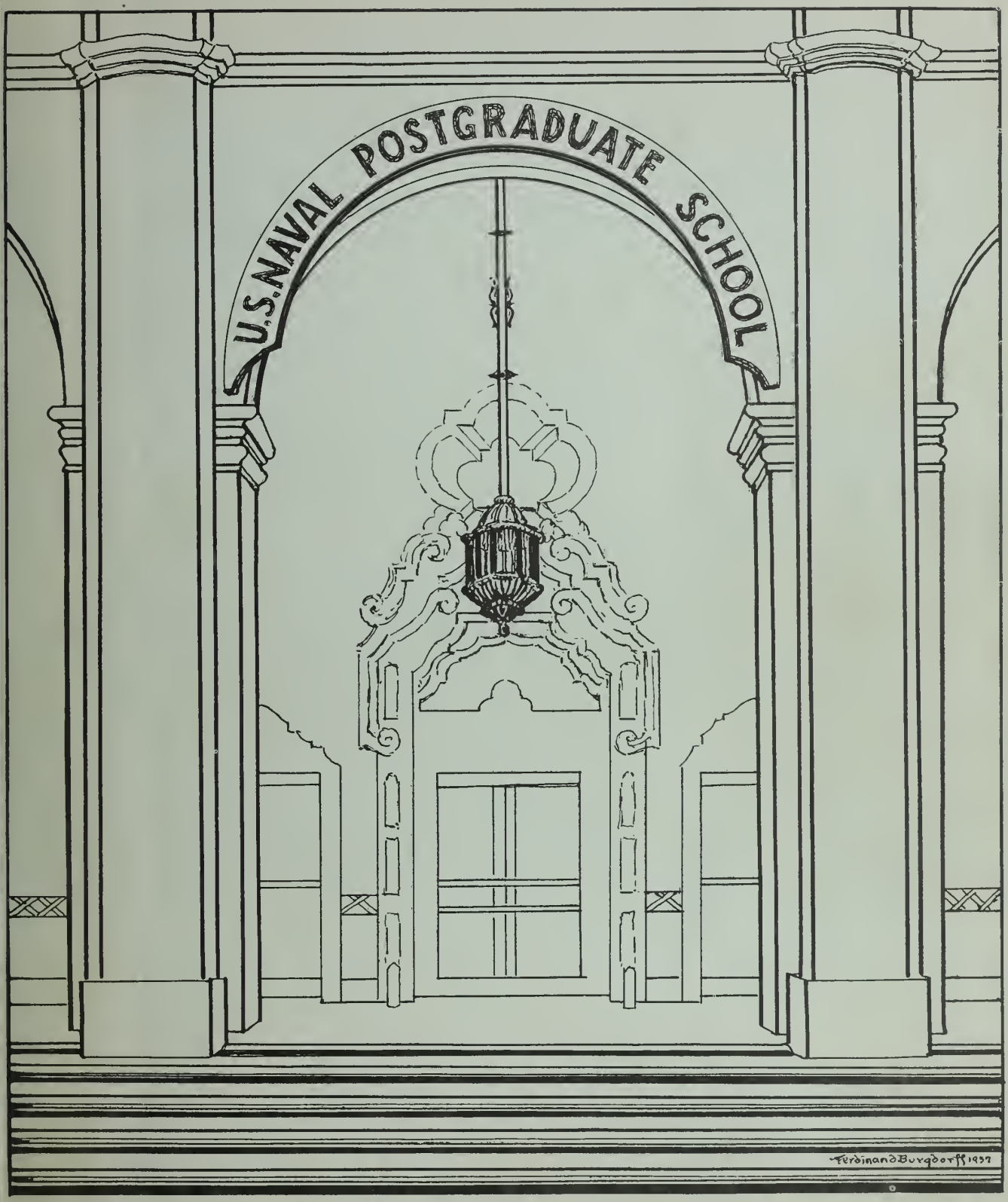
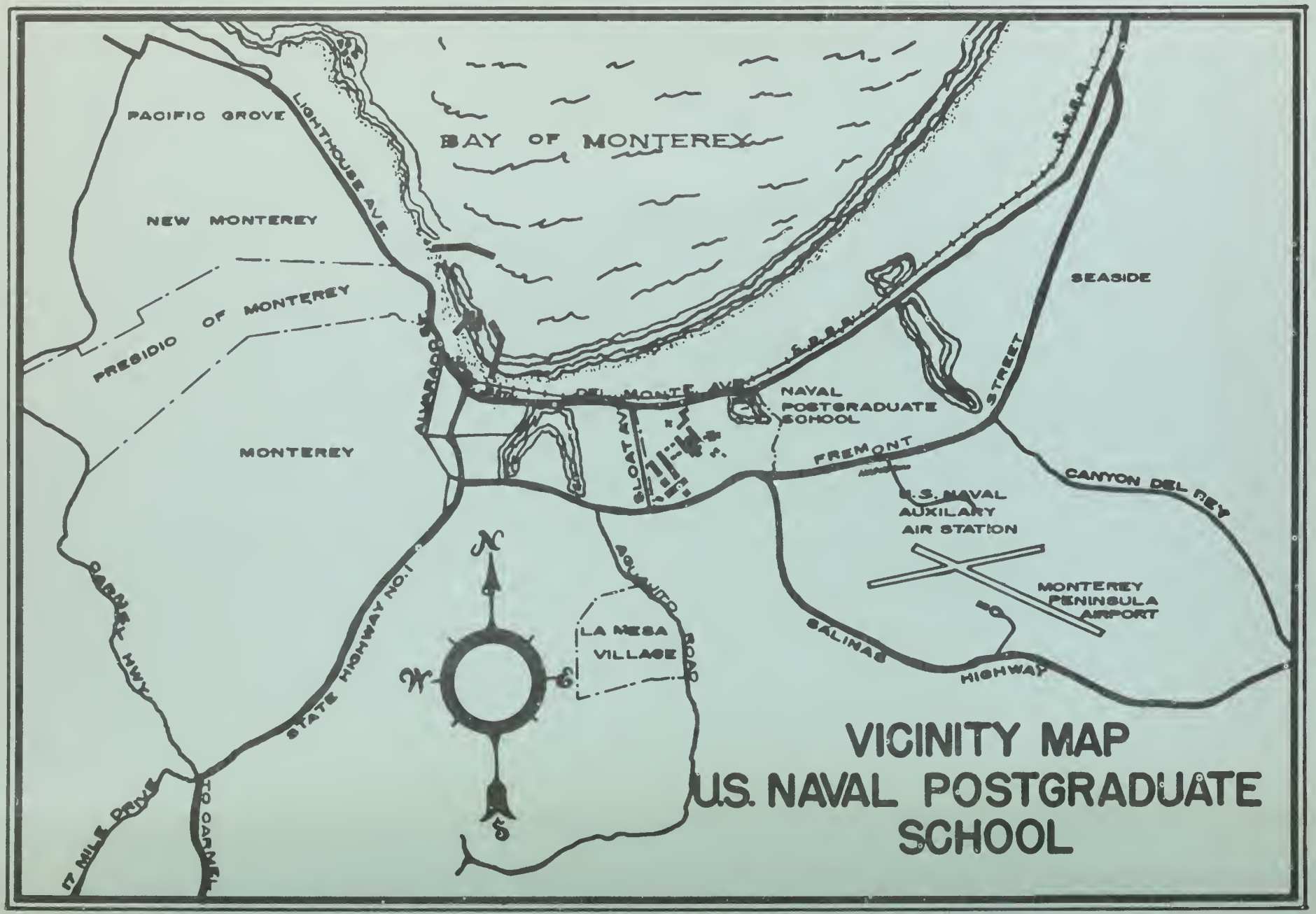


Catalogue for Academic Year 1957-1958



VICINITY MAP
U.S. NAVAL POSTGRADUATE SCHOOL

UNITED STATES NAVAL
POSTGRADUATE SCHOOL

CATALOGUE
for the
Academic Year 1957 - 1958

MONTEREY, CALIFORNIA

1 JUNE 1957

12ND P1664 (REV. 4-57)

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PRINTED BY
TWELFTH NAVAL DISTRICT
PUBLICATIONS AND PRINTING OFFICE

United States Naval Postgraduate School

Calendar

Academic Year 1957—1958

1957

General Line School Graduation (Class 1957A and Class 1957B(W)) and Management School Graduation	Wednesday, 19 June
General Line School Registration (Class 1957 C(W))	Thursday, 20 June
Independence Day (Holiday)	Thursday, 4 July
Registration for Management School, Engineering School and General Line School (Class 1958A)	Monday, 12 August
First Term Begins	Monday, 19 August
Labor Day (Holiday)	Monday 2, September
General Line School Graduation (Class 1957B and Class 1957C(W))	Wednesday, 23 October
First Term Ends	Friday, 25 October
Second Term Begins	Monday, 28 October
Veterans Day (Holiday)	Monday, 11 November
Thanksgiving Day (Holiday)	Thursday, 28 November
Christmas Leave Begins	Saturday, 21 December

1957

JANUARY

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1958

Christmas Leave Ends	Sunday, 5 January
General Line School Registration (Class 1958B and Class 1958A(W)) and Management School Registration	Monday, 13 January
Second Term Ends	Friday, 17 January
Management School Graduation	Friday, 17 January
Third Term Begins (First Term for General Line School (Class 1958B and Class 1958A(W))	Monday, 20 January
Washington's Birthday (Holiday)	Saturday, 22 February
Third Term Ends	Friday, 28 March
Fourth Term Begins	Monday, 31 March
Memorial Day (Holiday)	Friday, 30 May
Fourth Term Ends	Friday, 6 June
Management School, General Line School (Class 1958A and 1958A(W)) and Engineering School Graduation	Thursday, 12 June
Registration for Management School, Engineering School and General Line School	Monday, 11 August
Fifth Term Ends	Friday, 15 August
First Term Begins (Academic Year 1958-1959)	Monday, 18 August

1958

JANUARY

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OCTOBER

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NOVEMBER

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DECEMBER

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U. S. NAVAL POSTGRADUATE SCHOOL

—★—

Superintendent

Earl Everett STONE, Rear Admiral, U. S. Navy

BS USNA, 1917, M.S. Harvard, 1925

Chief of Staff

Jack Clayton RENARD, Captain, U. S. Navy

BS USNA, 1928

Academic Dean

Roy Stanley GLASGOW, B.S., M.S., E.E.

Director, Engineering School

Earl Tobias SCHREIBER, Captain, U. S. Navy

BS USNA, 1929

Director, General Line School

Williston Lemar DYE, Captain, U. S. Navy

BS USNA, 1929

Director, Management School

John Adrian HACK, Captain, U. S. Navy

BS USNA, 1935

Commanding Officer, Administrative Command

Maxim William FIRTH, Captain, U. S. Navy

BS USNA, 1931

MISSION

The Secretary of the Navy has defined the mission of the Naval Postgraduate School as follows:

> **"To conduct and direct the instruction of commissioned officers by advanced education, to broaden the professional knowledge of general line officers, and to provide such other indoctrination, technical and professional instruction as may be prescribed to meet the needs of the Naval Service."**

UNITED STATES NAVAL POSTGRADUATE SCHOOL

SECTION I

GENERAL INFORMATION

FUNCTIONS

In carrying out its mission the Postgraduate School performs the following functions: (a) provides advanced engineering education through its own facilities at Monterey, and by supervision of the education of officer students at various civilian institutions throughout the country; (b) provides advanced professional education through the medium of the General Line School; (c) provides graduate management education through the medium of the Management School. Through the performance of these functions the Postgraduate School becomes the agent of the Bureau of Naval Personnel for graduate education.

These functions stem from the mission which in turn has evolved over the years as a result of the recognized need for advanced education. The resulting program is essentially threefold: technical, special and professional. The technical phase is the particular province of the Engineering School which seeks, by graduate instruction, to provide officers with the facility for intelligent technical direction of the Navy's activities in such fields as electronics, ordnance, aerology, aeronautics, naval engineering and communications. This is done through the Engineering School facilities as well as by utilization of civilian institutions known for their leadership in the fields involved. Because of this latter contact, the Engineering School is also charged with the handling of such special programs as civil engineering, naval construction and engineering at civilian institutions.

The General Line School carries out that portion of the program dealing with professional naval subjects by augmenting previous instruction and training of the junior officer in the naval sciences, thereby rendering him more capable of employing all the tools of his profession and better fitting him for more responsible duties ashore and afloat.

The General Line School offers a nine and one-half month program similar to that which existed prior to World War II and designed to broaden and enhance the mental outlook and professional knowledge of all career line officers upon completion of five to seven years' commissioned service.

The Management School offers a five month program including courses in various business subjects and in the general field of management. This School provides Naval officers with graduate level instruction enabling them to be better prepared for their future assignments to management billets. It also has administrative responsibility for related curricula such as business and personnel administration offered at civilian universities.

In addition to the above, the Postgraduate School exercises general supervision over the Naval Intelligence School at Washington, D.C. Otherwise, the Intelligence School operates independently under a captain of the line who holds the title of director.

ORGANIZATION

The Postgraduate School consists of four main components: the Engineering School, the General Line School, the Management School, and the Administrative Command. Heading the organization is the superintendent, a rear admiral of the line of the Navy. He is assisted by captains of the line as heads of the four components. The Administrative Command is the supporting organization for the schools at Monterey and provides all the usual housekeeping services.

The three schools at Monterey, the Engineering School, the Management School, and the General Line School, each have a military and an academic organization. The civilian faculty of the three schools, headed by the academic dean, provides the academic instruction in fields usually found in a well-rounded technical institution. In addition, officer instructors provide education in the purely naval subjects. Because of their different functions the three schools have different proportions of officer and civilian instructors; the Engineering School teaching staff is preponderantly civilian, whereas the opposite is true in the case of the General Line School. The Management School staff is about equal in proportion of officer and civilian instructors.

STUDENT INFORMATION

Detailed information on the Postgraduate School and the Monterey area is provided in a student information brochure given to all newcomers. In general, however, the living facilities approach those detailed by the many travel folders available concerning the Monterey Peninsula.

Of particular interest to the married student is La Mesa Village, a Wherry housing development located within one mile of the school. The 519 units provide an excellent supplement to the general housing available throughout the Peninsula. The general housing facilities are adequately supported by schools, churches, and shopping facilities.

The majority of the rooms of the old Del Monte Hotel are used as a BOQ. Within the same buildings are the usual facilities associated with the BOQ, such as closed and open messes, Navy Exchange, etc.

The Naval Air Facility, Monterey, is is located about 2 miles from the school grounds. Its main mission is to provide the flight facilities for the use of aviator students in maintaining their flight proficiency.

FACILITIES

The Naval Postgraduate School is located about one mile east of the city of Monterey. This site is in the process of development aimed at the ultimate provision of modern classroom and laboratory facilities for the Engineering School the General Line School, and the Management School. When this objective is attained, the spaces now employed for classes and laboratories will revert to their primary purposes as BOQ and other supporting facilities.

During the latter part of 1954 the Engineering School moved into the first group of buildings completed as part of this development plan. These buildings provide proper laboratory space for the first time during the existence of the Engineering School. The following buildings are now in use:

The main Engineering School building, Spanagel Hall, five stories in height, which houses the departments of Electronics, Physics, Metallurgy and Chemistry, and Electrical Engineering. Because of the building's height, the top level supports special equipment for demonstrations in aerology and electronics.

Bullard Hall, the Electrical Engineering Laboratory.

Halligan Hall, the Mechanical Engineering and Aeronautical Engineering Laboratories.

Root Hall, primarily a classroom building, is a long, two-story building that also provides space for the Computer Laboratory and for the departments of Aeronautics, Mechanical Engineering, Aerology, and Mathematics and Mechanics. The Management School is also located in Root Hall as is the Reference and Research Library which is occupying about one-third of the building until such time as a separate library building is constructed.

LIBRARY

The Libraries of the U. S. Naval Postgraduate School, which contain various collections of published and unpublished materials for the use of students, faculty and staff of the Engineering School, the General Line School, and the Management School are three in number—the Reference and Research Library, the Christopher Buckley Library, and the Textbook Service.

The Reference and Research Library, temporarily located in the east end of Root Hall, is an active collection of some 150,000 books, periodicals and research reports dealing mainly with the curricular subjects in the fields of science, engineering, management and naval studies. Its research and development report collection, including a classified section, provides up-to-date information on research being done, under government-sponsored projects, by universities and by independent researchers. The Reference and Research Library also furnishes microfilm and photostat services and will obtain, on interlibrary loan, any publications which are requested and which are not present in its own collection.

The Christopher Buckley, Jr. Library, located on the first floor of Herrmann Hall is a collection of about 5,000 books relating mainly to naval history or to subjects connected with the sea. It contains, among these, many rare or otherwise valuable books, including Sir Walter Raleigh's "Excellent Observations and Notes, Concerning the Royall Navy and Sea-Service," published in 1650; Samuel Pepys' "Memoires Relating to the State of the Royal Navy of England for Ten Years, Determin'd December 1688"; the first edition (1773-1784) of Capt. James Cook's "Voyages," in eight volumes; a number of manuscripts, and many other interesting items. It is a comfortably furnished library in surroundings that are conducive to reading, relaxing, browsing or study. The collection was the result of the generosity and kindness of Mr. Christopher Buckley, resident of Pebble Beach, California, who has been donating books to the School for this Library since 1949, and who has designated it to be the testamentary recipient of his estate.

The Textbook Service contains approximately 90,000 textbooks, reference books and pamphlets in multiple copies, which are issued to students on a term-loan basis and to instructors for an unlimited period. Students are assigned certain specified texts for their courses but may use this Library to obtain related material to use in conjunction with them.

HISTORICAL

The U. S. Naval Postgraduate School had a modest beginning at the Naval Academy at Annapolis in 1909, at which time the first class of ten officers enrolled in a Marine Engineering curriculum. Today, in its location at Monterey, California, approximately 1,000 officer students are enrolled in ap-

proximately forty curricula in engineering and related subjects, in the Engineering School and the General Line School. Facilities are being planned and implemented to accommodate a total of 1400 officer students—500 in the Engineering School, 100 in the Management School, and 800 in the General Line School. Since 1909 the growth and development of the U. S. Naval Postgraduate School has been in keeping with its original objective of providing the Navy with officers of advanced technical education capable of administering and directing a modern Navy.

The need for technically trained officers became evident at the turn of the century. The idea of a naval graduate school had its inception in a course of instruction in Marine Engineering which the Bureau of Engineering instituted in 1904. The results of this course were so encouraging that in 1909 the Secretary of the Navy established a School of Marine Engineering at the Naval Academy in Annapolis. In 1912 the School was designated the Postgraduate Department of the U. S. Naval Academy.

The operation of the School was temporarily suspended during World War I, but in 1919 classes were resumed in converted Marine Barracks on the Naval Academy grounds. At this time curricula in Mechanical Engineering and Electrical Engineering were added. With the passing years other curricula—Ordnance Engineering, Radio Engineering, Aerological Engineering and Aeronautical Engineering—were added as the Navy's need for officers with technical knowledge in these fields became evident.

In 1927 the General Line Curriculum was established within the Postgraduate School to provide courses of instruction to acquaint junior line officers returning from sea duty with modern developments taking place in the Navy. The courses dealt with naval and military subjects for the most part. The General Line Curriculum remained as an integral part of the Postgraduate Department until the declaration of the emergency prior to the outbreak of World War II, at which time it was discontinued because of the need for officers in the growing fleet.

The enrollment in the Postgraduate School increased rapidly in the war years both in the several engineering curricula and in the communications curriculum which was added to meet the need for trained communication officers in the naval establishment. The School outgrew its quarters necessitating the building of an annex to house the additional classrooms and laboratories required, but even with this addition, the space requirements of the expanded school were not met.

The post-war program called for yet further expansion and the re-establishment of the General Line Curriculum with a greatly increased enrollment. In 1946 the General Line School was established at Newport, Rhode Island, as an outlying element of the Postgraduate School and continued until dis-established in 1952; in 1948 an additional General Line School was established at Monterey, California. The objective of the General Line School program—that of providing an integrated course in naval science to broaden the professional knowledge of unrestricted line officers of the Regular Navy—continued in effect as it had since the inception of this program. From 1946 until 1955 a curriculum varying in length from six months to one year provided such a course for Reserve and ex-Temporary officers who had transferred to Regular status. Since 1955, the curriculum has been nine and one-half months in duration and is intended for other Regular officers at the end of five to seven years of commissioned service.

The pnysical growth of the School and its increase in scope and importance were recognized in Congressional action which resulted in legislation during the years 1945 to 1951 emphasizing the academic level of the School, and providing for continued growth in a new location with modern buildings and equipment. This legislation authorized the School to confer Bachelors, Masters, and Doctors degrees in engineering and related subjects; created the position of academic dean to insure continuity in academic policy, established the School as a separate naval activity to be known as the United States Naval Postgraduate School; authorized the establishment of the School at Monterey, California; and provided funds to initiate the construction of buildings to house modern laboratories and classrooms at that location.

In December 1948 a survey was conducted by Region IV Committee on Engineering Schools of the Engineering Council for Professional Development (ECPD). As a result of this survey which was a detailed and thorough investigation of the curricula, faculty and facilities of the School, the Naval Postgraduate School was informed on 29 October 1949 by the ECPD that the Curricula in Aeronautical Engineering, Electrical Engineering (including option in Electronics) and Mechanical Engineering were accredited. In 1955 the School was accredited by the Western College Association and in the same year the ECPD reaccredited the curricula it had approved in 1949 and, in addition, accredited that in Ordnance Engineering (Special Physics).

On 22 December 1951, by order of the Secretary of the Navy, the United States Naval Postgraduate School was officially disestablished at Annapolis, Maryland, and established at Monterey, California. This completed the transfer of the School from the East to the West Coast, which had begun in 1948 when the Aerology Department and Curricular office were moved to the new location. Concurrently

with this relocation, the U. S. Naval School (General Line) at Monterey was disestablished as a separate military command and its functions and facilities were assumed by the U. S. Naval Postgraduate School. At the same time, there was established the U. S. Naval Administrative Command, U. S. Naval Postgraduate School, Monterey, to provide logistic support, including supply, public works, medical and dental functions, for the Naval Postgraduate School and its components.

In June 1956, by direction of the Chief of Naval Personnel, a Management School was established as an additional component of the Postgraduate School. The mission of the school is to provide an educational program for officers in the application of sound scientific management practice to the complex organizational structure and operations of the Navy with a view toward increasing efficiency and economy of operation. The first class included only Supply and Civil Engineering Corps officers and emphasis was placed on general management theory, financial management, and inventory management. In August 1957 this school will be expanded to include input from both Line and Staff Corps officers. The curriculum will then include various areas of industrial management and additional material in the basic areas.

The U. S. Naval Postgraduate School, Monterey, now comprises the Engineering School under a director, the General Line School under a director, the Management School under a director, and the Administrative Command under a commanding officer. In command of the Naval Postgraduate School and all of its components is a line officer of flag rank in the Regular Navy with the title of superintendent.

SECTION II

THE ENGINEERING SCHOOL

DIRECTOR

Earl Tobias SCHREIBER, Captain, U. S. Navy
B.S., USNA, 1929;
Graduate, USNPS, 1938, Marine Engineering;
U. S. Naval War College, 1950

Assistant to the Director

Jackson Madison RIGHTMYER
Commander, U. S. Navy

NAVAL STAFF

AEROLOGY CURRICULA

Arthur Albert CUMBERLEDGE
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1931; M.S., Massachusetts Institute of Technology, 1941.

Charles Ellis TILDEN
Commander, U. S. Navy
Assistant Officer in Charge
Instructor in Aerology
M.S., USNPS, 1951.

Harvey Franklin SMITH, Jr.
Commander, U. S. Navy
Instructor in Aerology
B.A., LaVerne College, 1941;
M.S., California Institute of Technology, 1946.

Richard Michael CASSIDY
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.A., Miami University, 1942.
USNPS, 1945, Aerological Engineering.

William Wheeler ELAM
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., Ohio University, 1945; M.S., USNPS, 1948.

John LaCAVA, Jr.
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., Connecticut State Teachers College, 1943;
M.S., USNPS, 1950.

Thomas Hall Robinson O'NEILL
Lieutenant, U. S. Navy
Instructor in Aerology
B.A., Mt. St. Mary's College, 1942;
M.S., USNPS, 1954.

Lester Donald FROM
Chief Aerographer, U. S. Navy
Instructor in Aerology

AERONAUTICAL ENGINEERING CURRICULA

Robert Leavenworth MASTIN
Commander, U. S. Navy
Officer in Charge
B.S., USNA, 1939; Ae.E., California Institute of Technology, 1947.

John Paul WHEATLEY
Commander, U. S. Navy
Assistant Officer in Charge
B.S., University of Washington, 1938;
M.S., Harvard University, 1939;
Ae. E., California Institute of Technology, 1947

COMMUNICATIONS CURRICULA

Henry Otto HANSEN
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1930; USNPS, 1938, Applied Communications.

Charles Alexander DARRAH
Commander, U. S. Navy
Assistant Officer in Charge
USNPS, 1944, Applied Communications.
B.A., Vanderbilt University, 1949.

Ned Allen GARDNER
Commander, U. S. Navy
Instructor in Communications

Karl John CHRISTOPH, Jr.
Lieutenant, U. S. Navy
Instructor in Communications
B.S., USNA, 1947 (1948A); USNPS, 1953, Applied Communications.

THE ENGINEERING SCHOOL

ENGINEERING ELECTRONICS CURRICULA

John McGavock GRIDER
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1932; USNPS, 1940, Radio Engineering; M.S., Harvard University, 1941.

John Victor PETERS
Lieutenant Commander, U. S. Navy
Assistant Officer in Charge
B.S., USNA, 1944; USNPS, 1952; M.S. in Engineering Electronics, USNPS, 1953.

Forrest John GODFREY
Lieutenant, U. S. Navy
Electronics Laboratory Officer

NAVAL ENGINEERING CURRICULA

Harold Millar HEMING
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1930; USNPS, 1939, Marine Engineering; U. S. Naval War College, 1950.

Schuyler Wilshear BACON
Commander, U. S. Navy
Assistant Officer in Charge
BME, Rensselaer Polytechnic Institute, 1939; M.S., USNPS, 1950.

Charles Allen BILBO
Lieutenant Commander, U. S. Navy
Laboratory and Machine Shop Officer

ORDNANCE ENGINEERING CURRICULA

Carter Lowe BENNETT
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1933; M. S., Massachusetts Institute of Technology, 1942; Industrial College of the Armed Forces, 1953.

Thomas Roderick EDDY
Commander, U. S. Navy
Assistant Officer in Charge and Instructor in Ordnance Engineering
B.S., USNA, 1939; M.S., Massachusetts Institute of Technology, 1947.

George Thomas RAGON
Lieutenant Commander, U. S. Navy
Instructor in Mine Warfare
B.S., USMMA, 1944; Univ. of Texas, 1951.

CIVILIAN FACULTY

DEPARTMENT OF AEROLOGY

William Dwight DUTHIE
Professor of Aerology; Chairman (1945)
A.B., Univ. of Washington, 1935; M. S., 1937; Ph.D. Princeton Univ., 1940.

George Joseph HALTINER
Professor of Aerology (1946)
B.S., College of St. Thomas, 1940; Ph. M., Univ. of Wisconsin, 1942; Ph.D. 1948.

Frank Lionel MARTIN
Professor of Aerology (1947)
A.B., Univ. of British Columbia, 1936; A.M., 1938; Ph.D., Univ. of Chicago, 1941.

Robert Joseph RENARD
Assistant Professor of Aerology (1952)
M.S., Univ. of Chicago, 1952.

Charles Luther TAYLOR
Assistant Professor of Aerology, (1954)
B.S., Pennsylvania State University, 1942; M.S., 1947.

Warren Charles THOMPSON
Associate Professor of Aerology and Oceanography (1953)
A.B., Univ., of California at Los Angeles, 1943; M.S., Scripps Institution of Oceanography, 1948; Ph.D., Texas A. & M. College, 1953.

Jacob Bertram WICKHAM
Assistant Professor of Aerology and Oceanography (1951)
B.S., Univ. of California, 1947; M.S., Scripps Institution of Oceanography, 1949.

DEPARTMENT OF AERONAUTICS

Wendell Marois COATES
Professor of Aeronautics; Chairman (1931)
A.B., Williams College, 1919; M.S., Univ of Michigan, 1923; D.Sc., 1929.

Richard William BELL
Professor of Aeronautics (1951)
A.B., Oberlin College, 1939; Ae.E., California Institute of Technology, 1941.
(On leave of absence).

(The year of joining the Postgraduate School faculty is indicated in parenthesis.)

Theodore Henry GAWAIN
Professor of Aeronautics (1951)
B.S., Univ. of Pennsylvania, 1940; D.Sc., Massachusetts Institute of Technology, 1944.

Ulrich HAUPT
Associate Professor of Aeronautics (1954)
Dipl. Ing., Institute of Technology, Darmstadt, 1934.

Richard Moore HEAD
Professor of Aeronautics (1949)
B.S., California Institute of Technology, 1942; M.S., 1943; Ae.E., 1943; Ph.D., 1949.

George Judson HIGGINS
Professor of Aeronautics (1942)
B.S., Univ. of Michigan, 1923; Ae.E., 1934.

Charles Horace KAHR, Jr.
Associate Professor of Aeronautics (1947)
B.S., Univ. of Michigan, 1944; M.S., 1945.

Henry Lebrecht KOHLER
Professor of Aeronautics (1943)
B.S., Univ. of Illinois, 1929; M.S., Yale Univ., 1930; M.E., 1931.

Michael Hans VAVRA
Professor of Aeronautics (1947)
Dipl. Ing., Swiss Federal Institute of Technology, 1934.

DEPARTMENT OF ELECTRICAL ENGINEERING

Charles Van Orden TERWILLIGER
Professor of Electrical Engineering
Chairman (1925)
B.E., Union College, 1916; M.S., 1919; M.S., Harvard Univ., 1922; D.Eng., Johns Hopkins Univ., 1938.

Charles Benjamin OLER
Associate Professor of Electrical Engineering (1946)
B.S., Univ. of Pennsylvania, 1927; M.S., 1930; D.Eng., Johns Hopkins Univ., 1950.

Orval Harold POLK
Professor of Electrical Engineering (1946)
B.S., Univ of Colorado, 1927; M. S., Univ. of Arizona, 1933; E.E., Univ. of Colorado, 1940.

Charles Harry ROTHAUGE
Professor of Electrical Engineering (1949).
B.E., Johns Hopkins Univ., 1940; D.Eng., 1949.

William Conley SMITH
Professor of Electrical Engineering (1946)
B.S., Ohio Univ., 1935; M.S., 1939.

William Alfred STEIN
Associate Professor of Electrical Engineering (1951)
B.S., Washington Univ., 1943; M.S., 1947; D.Sc 1951.

George Julius THALER
Professor of Electrical Engineering (1951)
B.E., Johns Hopkins Univ., 1940; D.Eng., 1947.

Allen Edgar VIVELL
Professor of Electrical Engineering (1945)
B.E., Johns Hopkins Univ., 1927; D.Eng., 1937.

Richard Carvel Hensen WHEELER
Professor of Electrical Engineering (1929)
B.E., Johns Hopkins Univ., 1923; D.Eng., Rensselaer Polytechnic Institute, 1926.

DEPARTMENT OF ELECTRONICS

George Robert GIET
Professor of Electronics; Chairman (1925)
A.B., Columbia Univ., 1921; E.E., 1923.

William Malcolm BAUER
Professor of Electronics (1946)
B.S., Northwestern Univ., 1927; E. E., 1928; M.S., Harvard Univ., 1929; D.Sc., 1940.

Jesse Gerald CHANEY
Professor of Electronics (1946)
A.B., Southwestern Univ., 1924; A.M., Univ. of Texas, 1930.

Paul Eugene COOPER
Professor of Electronics (1946)
B.S., Univ. of Texas, 1937; M.S., 1939.

Mitchell Lavette COTTON
Assistant Professor of Electronics (1953)
B.S., California Institute of Technology, 1948; M.S., Washington Univ., 1952; E. E., Univ. of California, 1954.

John James DOWNING
Instructor in Electronics (1952)
B.S., Massachusetts Institute of Technology, 1948. M.S., USNPS, 1956.

Clarence Frederick KLAMM, Jr.
Associate Professor of Electronics (1951)
B.S., Washington Univ., 1943; M.S., 1948.

Carl Ernest MENNEKEN
Professor of Electronics (1942)
B.S., Univ. of Florida, 1932; M.S., Univ. of Michigan, 1936.

Robert Lee MILLER
Associate Professor of Electronics (1946)
B.Ed., Illinois State Normal Univ., 1936; M.S., Univ. of Illinois, 1942.

Marvin Paul PASTEL
Assistant Professor of Electronics (1955)
B.S., Principia College, 1947; M.S. Washington University, 1948.

Abraham SHEINGOLD
Professor of Electronics (1946)
B.S., College of the City of New York, 1936; M.S., 1937.

Donald Alan STENTZ
Assistant Professor of Electronics (1949)
B.S., Duke Univ., 1949.

John Benjamin TURNER, Jr.
Assistant Professor of Electronics (1955)
B.S., University of Arkansas, 1941; M. S., University of California, 1948.

Carl Paul WIEDOW
Associate Professor of Electronics (1956)
A.B., Occidental College, 1933; M.S. University of Southern California, 1935; M. S. (Physics), California Institute of Technology, 1945; M.S., (E.E.), California Institute of Technology, 1946; Ph.D., Oregon State College, 1956.

DEPARTMENT OF MATHEMATICS AND MECHANICS

Warren Randolph CHURCH
Professor of Mathematics and Mechanics; Chairman (1938)
A.B., Amherst, 1926; A.M., Univ. of Pennsylvania, 1930; Ph.D., Yale Univ., 1935.

Ralph Eugene ROOT
Professor Emeritus of Mathematics (1914)
B.S., Morningside College, 1905; A.M., Univ. of Iowa, 1909; Ph.D., Univ. of Chicago, 1911.

Charles Henry RAWLINS, Jr.
Professor Emeritus of Mathematics and Mechanics(1922)
Ph.B., Dickinson College, 1910; A.M., 1913; Ph.D., Johns Hopkins Univ., 1916.

Willard Evan BLEICK
Professor of Mathematics and Mechanics (1946)
M.E., Stevens Institute of Technology, 1929; Ph.D., Johns Hopkins Univ., 1933.

Richard Crowley CAMPBELL
Associate Professor of Mathematics and Mechanics (1948)
B.S., Muhlenberg College, 1940; A.M., Univ. of Pennsylvania, 1942.

Frank David FAULKNER
Associate Professor of Mathematics and Mechanics (1950)
B.S., Kansas State Teachers College, 1940; M.S., Kansas State College, 1942.

Joseph GIARRATANA
Professor of Mathematics and Mechanics (1946)
B.S., Univ. of Montana, 1928; Ph.D., New York Univ., 1936.

Walter JENNINGS
Associate Professor of Mathematics and Mechanics (1947)
A.B., Ohio State Univ., 1932; B.S., 1934; A.M. 1934.

Brooks Javins LOCKHART
Professor of Mathematics and Mechanics (1948)
A.B., Marshall College, 1937; M.S., West Virginia Univ., 1940; Ph.D., Univ. of Illinois, 1943.

Craig A. MAGWIRE
Associate Professor of Mathematics and Mechanics (1955)
B.A., Nebraska State Teachers College, 1943; M.S., Univ. of Michigan, 1947; Ph.D. Stanford Univ., 1953.

Hugo Murua MARTINEZ
Associate Professor; Supervisor of Computation Laboratory (1955)
B.A., Univ. of California, 1952.

Aladuke Boyd MEWBORN
Professor of Mathematics and Mechanics (1946)
B.S., Univ. of Arizona, 1927; M.S., 1933; Ph.D., California Institute of Technology, 1940.

Thomas Edmond OBERBECK
Professor of Mathematics and Mechanics (1951)
A.B., Washington Univ., 1938; A.M., Univ. of Nebraska, 1940; Ph.D., California Institute of Technology, 1948.

John Philip PIERCE
Associate Professor of Mathematics and Mechanics (1948)
B.S., Worcester Polytechnic Institute, 1931
M.E.E., Polytechnic Institute of Brooklyn, 1937.

Francis McConnell PULLIAM
Professor of Mathematics and Mechanics (1949)
A.B., Univ. of Illinois, 1937; A.M., 1938; Ph.D. 1947.

Elmo Joseph STEWART
Associate Professor of Mathematics and Mechanics (1955)
B.S., Univ. of Utah, 1937; M.S., 1939; Ph.D., Rice Institute, 1953.

Charles Chapman TORRANCE
Professor of Mathematics and Mechanics (1946)
M.E., Cornell Univ., 1922; A.M., 1927; Ph.D., 1931.

DEPARTMENT OF MECHANICAL ENGINEERING

Robert Eugene NEWTON
Professor of Mechanical Engineering; Chairman (1951)
B.S., Purdue University, 1938; M.S.E., 1941; Ph.D., Univ. of Michigan, 1951.

Paul James KIEFER
Professor Emeritus of Mechanical Engineering (1920)
A.B., Wittenberg College, 1908; B.S., Case Institute of Technology, 1911; M.E., 1939; D.Sc., (Hon.) Wittenberg College, 1953.

John Edison BROCK
Professor of Mechanical Engineering (1954)
B.S., Purdue University, 1938; M.S., 1941; Ph.D., University of Minnesota, 1950.

Ernest Kenneth GATCOMBE
Professor of Mechanical Engineering (1946)
B.S., Univ. of Maine, 1931; M.S., Purdue Univ., 1939; Ph.D., Cornell Univ., 1944.

Charles Pinto HOWARD
Assistant Professor of Mechanical Engineering (1954)
B.S., Texas Agricultural and Mechanical College, (1949); M.S., 1951.

Dennis KAVANAUGH
Professor of Mechanical Engineering (1926)
B.S., Lehigh Univ., 1914.

Cecil Dudley Gregg KING
Assistant Professor of Mechanical Engineering (1952)
B.E., Yale Univ., 1943; M.S., Univ. of California, 1952.

Roy Walters PROWELL
Professor of Mechanical Engineering (1946).
B.S., Lehigh Univ., 1936; M.S., Univ. of Pittsburgh, 1943.

Paul Francis PUCCI
Assistant Professor of Mechanical Engineering (1956).
B.S., Purdue University, 1949, M.S., 1950; Ph.D., Stanford University, 1955.

Harold Marshall WRIGHT
Professor of Mechanical Engineering (1945)
B.S., North Carolina State College, 1930; M.M.E., Rensselaer Polytechnic Institute, 1931.

DEPARTMENT OF METALLURGY AND CHEMISTRY

Frederick Leo COONAN
Professor of Metallurgy and Chemistry; Chairman (1931)
A.B., Holy Cross College, 1922; M.S., 1924; D.Sc., Massachusetts Institute of Technology, 1931.

Newton Weber BUERGER
Professor of Metallurgy (1942)
B.S., Massachusetts Institute of Technology, 1933; M.S., 1934; Ph.D. 1937.

John Robert CLARK
Professor of Metallurgy (1947)
B.S., Union College, 1935; D.Sc., Massachusetts Institute of Technology, 1942.

Alfred GOLDBERG
Assistant Professor of Metallurgy (1953)
B.Eng., McGill Univ., 1946; M.S., Carnegie Institute of Technology, 1947; Ph.D., University of California, 1955.

William Wisner HAWES
Associate Professor of Metallurgy and Chemistry (1952)
B.S., Purdue Univ., 1924; M.S., Brown Univ., 1927; Ph.D., 1930.

Carl Adolph HERING
Professor of Chemical Engineering (1946)
B.S., Oregon State College, 1941; M.S., Cornell Univ., 1944.

Gilbert Ford KINNEY
Professor of Chemical Engineering (1942)
A.B., Arkansas College, 1928; M.S., Univ. of Tennessee, 1930; Ph.D., New York Univ., 1935.

Lloyd Randall KOENIG
Instructor in Chemical Engineering (1950)
B.S., Washington Univ., 1950. (On military leave)

George Daniel MARSHALL, Jr.
Professor of Metallurgy (1946)
B.S., Yale Univ., 1930; M.S., 1932.

George Harold McFARLIN
Professor of Chemistry (1948)
A.B., Indiana Univ., 1925; A.M., 1926.

Richard Alan REINHARDT
Assistant Professor of Chemistry (1954)
B.S., Univ., of California, 1943; Ph.D., 1947.

Melvin Ferguson REYNOLDS
Professor of Chemistry (1946)
B.S., Franklin and Marshall College, 1932; M.S., New York Univ., 1935; Ph.D., 1937.

James Edward SINCLAIR
Assistant Professor of Chemistry (1949)
B.S., Johns Hopkins Univ., 1945; M.S., USNPS, 1956.

James Woodrow WILSON
Associate Professor of Chemical Engineering (1949)
A.B., Stephen F. Austin State Teachers College, 1935; B.S., Univ. of Texas, 1939; M.S., Texas Agricultural and Mechanical College, 1941.

DEPARTMENT OF PHYSICS

Austin Rogers FREY
Professor of Physics; Chairman (1946)
B.S., Harvard Univ., 1920; M. S., 1924; Ph.D., 1929.

Roderick Keener CLAYTON
Associate Professor of Physics (1952)
B.S., California Institute of Technology, 1947; Ph.D., 1951.

John Niessink COOPER
Professor of Physics (1956)
A.B., Kalamazoo College, 1935; Ph.D., Cornell University, 1940.

Eugene Casson CRITTENDEN, Jr.
Professor of Physics (1953)
A.B., Cornell Univ., 1934; Ph.D., 1938.

William Peyton CUNNINGHAM
Professor of Physics (1946)
B.S., Yale Univ., 1928; Ph.D., 1932.

Sydney Hobart KALMBACH
Associate Professor of Physics (1947)
B.S., Marquette Univ., 1934; M. S., 1937.

Lawrence Edward KINSLER
Professor of Physics (1946)
B.S., California Institute of Technology, 1931; Ph.D., 1934.

Herman MEDWIN
Associate Professor of Physics (1955)
B.S., Worcester Polytechnic Institute, 1941; M.S., Univ. of California at Los Angeles, 1948; Ph.D., Univ. of California at Los Angeles, 1953.

Edmund Alexander MILNE
Assistant Professor of Physics (1954)
B.A., Oregon State College, 1949; M. S., California Institute of Technology, 1950; Ph.D., 1953.

Norman Lee OLESON
Professor of Physics (1948)
B.S., Univ. of Michigan, 1935; M.S., 1937; Ph.D., 1940.

LIBRARY

George Ridgely LUCKETT
Professor; Director of Libraries (1950)
B.S., Johns Hopkins Univ., 1949; M.S., Catholic Univ., 1951.

Morris HOFFMAN
Associate Professor; Associate Librarian (1952)
B.S., Univ. of Minnesota, 1947; A.M., 1949.

Jack Benjamin GOLDMANN
Assistant Professor; Public Services Librarian (1952)
A.B., Univ. of California, 1939; A.M., 1940; B.L.S., 1950.

Janusz Ignacy KODREBSKI
Head Catalog Librarian (1956)
Secondary education, Torun, Poland, 1927
Diploma National War College, Warsaw, 1938
M.S., University of Southern California 1955.

Georgia Plummer LYKE
Reference Librarian (1952)
A.A., Hartnell Junior College, 1940.

Daveda B. PARK
Cataloger (1955)
A.B., Univ. of California, 1938.

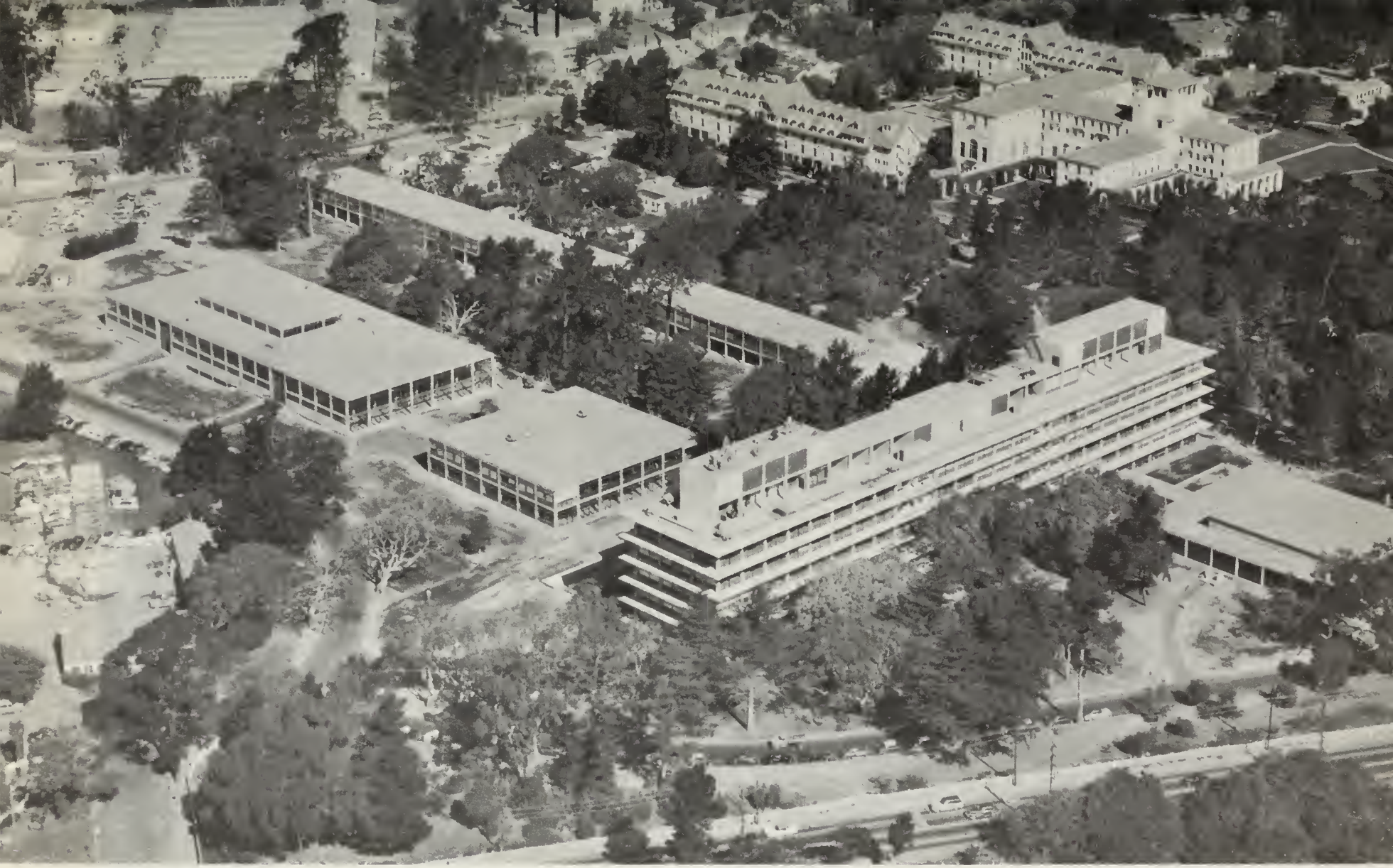
Marjorie I. THORPE
Technical Reports Librarian (1952)
A.B., Univ. of California at Los Angeles, 1942; B.S., Univ. of Southern California, 1943.

Robert Moran TIERNEY
Acquisitions Librarian (1957)
A.B., Columbia Univ., 1937.

Mabel C. VAN VORHIS
Technical Reports Cataloger (1955)
A.B., Univ. of California, 1926.

Herrmann Hall, the administrative Building. This building contains offices of the Superintendent, Academic Dean and Administrative Command, as well as the Bachelor Officers' Quarters and certain logistic facilities.

The Naval Postgraduate School is ideally located on 293 acres extending to Monterey Bay. The new Engineering School buildings are seen on the left and the Administration building at the right.



Aerial photograph of the School showing in the foreground the five new Engineering School buildings, and in the background the Administration Building, General Line School, and Bachelor Officers Quarters.

THE CHAPEL

FUNCTIONS

The Engineering School is responsible for the accomplishment of that part of the mission of the Postgraduate School that provides for "advanced education . . . and technical instruction . . . as may be prescribed to meet the needs of the service." It performs these functions through its own facilities at Monterey and by cooperation with the various civilian educational institutions throughout the country.

The variety of advanced education required by the Navy ranges from the basically technical, such as engineering electronics, through advanced study of pure science to law and religion. To cover this wide field several methods of education are used. In some cases the curriculum is conducted entirely at the Engineering School; in others, a civilian institution is employed; and in still others, both means are used.

ORGANIZATION

The Engineering School is organized under its director to carry out its functions along two basic lines; i.e., naval administration and academic instruction. The former provides the professional supervision of all the curricula and the latter provides the technical instruction and educational advice.

Under the director, the naval administration is provided by six curricular offices staffed by captains or commanders of the Navy experienced in their respective fields. The titles of these various "officers in charge" are:

(a) Aerology
(b) Aeronautical Engineering
(c) Communications
(d) Engineering Electronics
(e) Naval Engineering
(f) Ordnance Engineering

These officers provide the naval administration of the students undertaking curricula under their cognizance as well as the supervision of the curricula to insure that the needs of the service are met. They also supervise curricula in allied fields.

The educational side of the Engineering School is provided almost entirely by the civilian faculty. This group is organized along the lines of most civilian graduate institutions. There are eight academic departments, each headed by a chairman, as follows:

Aerology	Mathematics and Mechanics
Aeronautics	Mechanical Engineering
Electrical Engineering	Metallurgy and Chemistry
Electronics	Physics

In addition to providing the actual technical instruction, the academic departments provide educational advice to the curricular officers both directly as a department and through the assignment of an associate for a particular curricula. The academic associate assists the officer in charge in devising the curriculum and directing the students assigned in pursuing it.

The curricula offices also provide instruction in specifically naval subjects where an officer's experience is the most valuable background for the education to be imparted. Thus the naval staff and civilian faculty together provide a broad course of instruction.

ACADEMIC RECORDS

The course designation and marking system in use by the Engineering School is designed to facilitate the evaluation of both the curricula and the students for degree purposes. The regulations for degrees as set forth in later paragraphs require a certain quality point rating to be obtained by the students in courses of a clearly graduate nature.

Courses are assigned designators consisting of a two-letter abbreviation of the subject (Ma for Mathematics, Co for Communications), a three-digit course number, and a letter (A, B, C, or L) in parentheses, such as Ma-101(C) and Ph-643(A).

The letters in parentheses are a measure of the graduate standing of the course as follows:

(A) Full graduate course;
(B) Partial graduate course;
(C) Undergraduate course;
(L) Lecture course—no academic credit.

Course listings include the hours assigned, the hours of recitation first and laboratory second, separated by a dash; e.g., CH-412(C) 3-2. This means three hours of lecture and two hours of laboratory work per week. For credit purposes laboratory hours are assigned half weight, hence the example above has a credit hour value of 4 term hours. This corresponds to 2.67 semester hours, since each term hour is the equivalent of two-thirds semester hour.

Marks are assigned each student in accordance with the following schedule:

Performance	Grade	Quality Point Number
Excellent	A	3.0
Good	B	2.0
Fair	C	1.0
Barely passing	D	.0
Failure	X	—1.0

When the value of the course in credit hours is multiplied by the quality point number, corresponding to the grade assigned, the total quality points for that course is obtained. When this is totaled for all courses taken and divided by the total credit hours, a numerical evaluation of the various grades is obtained which is called the quality point rating or more simply, QPR. A student realizing a QPR of 2.0 has made a B average for all the courses he has undertaken.

REGULATIONS GOVERNING THE AWARD OF DEGREES

In accordance with Public Law 303 of the 79th Congress, with the Regulations prescribed by the Secretary of the Navy, and with accreditation by the Engineers' Council for Professional Development, the superintendent is authorized to confer the degree of Bachelor of Science in the Mechanical Engineering, the Electrical Engineering, the Engineering Electronics and the Aeronautical Engineering curricula. The recipients of such degrees must be found qualified by the Academic Council in accordance with certain academic standards.

The superintendent is further authorized to confer Masters and Doctors degrees in engineering or related fields, upon the recommendation by the faculty, based upon satisfactory completion of a program of advanced study approved by the Academic Council.

The following paragraphs set forth the requirements for the degrees:

(1) Requirements for the Bachelor of Science Degree:

(a) The Bachelor's degree in engineering or other scientific fields may be awarded for successful completion of a curriculum which serves the needs of the Navy and has the approval of the Academic Council as meriting a degree. Such a curriculum shall conform to current practice in accredited engineering institutions and shall contain a well-defined major, with appropriate cognate minors.

(b) Admission with suitable advanced standing and a minimum of two academic years of residence at the Naval Postgraduate School are normally required. With the approval of the Academic Council, this residence requirement may be reduced to not less than one academic year in the case of particular students who have had sufficient prior preparation at other institutions.

(c) To be eligible for the degree, the student must attain a minimum average quality point rating of 1.0 in all the courses of his curriculum. In very exceptional cases, small deficiencies from this figure may be waived at the discretion of the Academic Council.

(d) With due regard for the above requirements, the Academic Council will decide whether or not to recommend the candidate to the Superintendent of the Naval Postgraduate School for the award of the Bachelor's degree.

(2) Requirements for the Master of Science Degree:

(a) The Master's degree in engineering and related fields is awarded for the successful completion of a curriculum which complements the basic scientific education of a student and which has been approved by the Academic Council as meriting a degree, provided the student exhibits superior scholarship, attains scientific proficiency, and meets additional requirements as stated in the following paragraphs.

(b) Since curricula serving the needs of the Navy ordinarily contain undergraduate as well as graduate courses, a minimum of two academic years of residence at the Naval Postgraduate School is normally required. With the approval of the Academic Council, the time of residence may be reduced in the case of particular students who have successfully pursued graduate study at other educational institutions. In no case will the degree be granted for less than one academic year of residence at the Naval Postgraduate School.

(c) A curriculum leading to a Master's degree shall comprise not less than 48 term hours (32 semester hours) of work that is clearly of graduate level, and shall contain a well-supported major, together with cognate minors. At least six of the term hours shall be in advanced mathematics. The proposed program shall be submitted to the cognizant department chairman for review and approval. If the program is satisfactory to the department chairman, it shall be forwarded by him to the Academic Council for final action.

(d) To become a candidate for the Master's degree the student shall have completed at least three quarters of the graduate credit courses of his curriculum with a quality point rating in them of not less than 1.75 as defined in the section on scholarship.

(e) To be eligible for the Master's degree, the student must attain a minimum average quality point rating of 2.0 in all graduate credit courses; 1.5 in all of his other courses. In special cases, under very extenuating circumstances, small deficiencies from the figures noted in paragraphs (d) and (e) may be waived at the discretion of the Academic Council.

(f) A reasonable proportion of the graduate work leading to the Master's degree shall be composed of research and a thesis reporting the results obtained. The thesis topic is selected by the student in conjunction with a faculty advisor, and is subject to the approval of the cognizant department chairman. The research must indicate ability to perform independent work; the thesis grades entered by the faculty advisor are assigned on this basis. In addition, the completed thesis must indicate an ability to report on the work in a scholarly fashion. The thesis in final form is submitted via the faculty advisor to the cognizant department chairman for review and evaluation. Upon final approval of the thesis the student shall be certified as eligible for examination.

(g) If the thesis is accepted, the candidate for the degree shall take a final oral examination, the duration of which will be approximately one hour. An additional comprehensive written examination may be required at the discretion of the cognizant department chairman. Not more than one half of the oral examination shall be devoted to questions directly related to the candidate's thesis topic; the remainder to the candidate's major and related areas of study.

(h) With due regard for the above requirements, the Academic Council will decide whether or not to recommend the candidate to the superintendent of the Naval Postgraduate School for the award of the Master's degree.

(3) Requirements for the Doctor's Degree:

(a) The Doctor's degree in engineering and related fields is awarded as a result of very meritorious and scholarly achievement in a particular field of study which has been approved by the Academic Council as within the purview of the Naval Postgraduate School. A candidate must exhibit faithful and scholarly application to all prescribed courses of study, achieve a high level of scientific advancement and establish his ability for independent investigation, research, and analysis. He shall further meet the requirements described in the following paragraphs.

(b) Any program leading to the Doctor's degree shall require the equivalent of at least three academic years of study beyond the undergraduate level, and shall meet the needs of the Navy for advanced study in the particular area of investigation. At least one academic year of the doctorate work shall be spent at the Naval Postgraduate School.

(c) A student seeking to become a candidate for the doctorate shall hold a Bachelor's degree from a college or university, based on a curriculum that included the prerequisites for full graduate status in the department of his major study, or he shall have pursued successfuly an equivalent course of study. The student shall submit his previous record to the Academic Council, via the Academic Dean, for final determination of the adequacy of his preparation.

(d) Upon favorable action by the Academic Council, the student will be notified that he may request the chairman of the department of his major subject to form a Doctorate Committee. This chairman will specify one or more minor subjects and, with the chairmen of the corresponding departments, will nominate a Doctorate Committee consisting of five or more members, at least three of whom are under different departments. The chairman of the department of the major subject will submit to the Academic Council for its approval the choice of minor fields and the names of the faculty members nominated for the Doctorate Committee.

(e) After a sufficient period of study in his major and minor fields, the student shall submit to qualifying examinations, including tests of his reading knowledge of foreign languages. The selection of these languages depends on the field of study. The minimum is a reading knowledge of German and a second language to be suggested by his Doctorate Committee and approved by the Academic Council. The language examinations will be conducted by a committee especially appointed by the Academic Council. The other qualifying examinations will cover material previously studied in his major and minor fields; they will be written and oral and will be conducted by the Doctorate Committee. The members of the Academic Council or their delegates may be present at the oral examinations. The Doctorate Committee will report the results of the qualifying examinations to the Academic Council for consideration and, upon approval, the student becomes a candidate for the Doctorate. The qualifying examinations are not given, ordinarily, before the completion of the first year of residence at the Naval Postgraduate School; they must be passed successfully at least two years before the degree is granted.

(f) Upon successful qualification as a candidate, the student will be given a further program of study by the Doctorate Committee. This program must be approved by the Academic Council.

(g) The distinct requirement of the doctorate is the successful completion of an original, significant, and scholarly investigation in the candidate's major area of study. The results of the investigation, in the form of a publishable dissertation, must be submitted to the Academic Council at least two months

before the time at which it is hoped the degree will be granted. The Academic Council will select two or more referees, who will make individual written reports on the dissertation. Lastly, the Academic Council will vote upon the acceptance of the dissertation.

(h) After the approval of the dissertation, and not later than two weeks prior to the award of the degree, the candidate will be subject to written and oral examination in his major and minor subjects. Written examinations will be conducted by the department having cognizance of the particular subject. The occasion and scope of each examination will be arranged by the Doctorate Committee, after consultation with the departments concerned and the members of the Academic Council. The Doctorate Committee will notify the Academic Council of the time of the oral examination and will invite their attendance, or that of their delegates. The Committee will also invite the attendance of such other interested persons as it may deem desirable. In this oral examination, approximately one half of the allotted time will be devoted to the major subject and one half to the minor subjects. The Doctorate Committee will submit the results of all examinations to the Academic Council for their approval.

(i) With due regard for all of the above requirements, the Academic Council will decide whether to recommend the candidate to the Superintendent of the Naval Postgraduate School for the award of the doctorate.

(j) It is not to be expected that the course requirements for the doctorate can be met while pursuing one of the three-year curricula shown in this catalogue unless the student has previously had suitable graduate work and signifies his desire to become a candidate within three months of the beginning of his curriculum.

LABORATORY FACILITIES AND EQUIPMENT OF THE ENGINEERING SCHOOL

Extensive laboratory experimentation is carried on at the Engineering School in connection with the instructional and research programs of the various departments. The experimental facilities have been greatly improved and expanded in recent years, and further improvement is planned for the future.

The **Physics** laboratories are equipped to carry on experimental and research work in acoustics, atomic physics, electricity, nuclear physics, geometrical and physical optics, bio-physics, and solid state physics.

The laboratory facilities include a two-million volt Van de Graaff nuclear accelerator, a Collins liquid helium cryostat, a large grating spectograph, a medium size anechoic (echo-free) chamber, a small reverberation chamber, and a multiple-unit acoustics laboratory for student experimentation in airborne acoustics.

The work in the acoustics laboratory is particularly directed toward underwater sound applications, and a large proportion of the laboratory space is devoted to sonar equipment, test tanks, and instrumentation for investigations in underwater sound.

The **Aeronautical** laboratories contain facilities for experimentation and research in aerodynamics, structural and stress analysis, aerothermodynamics and propulsion problems.

Facilities for the study of subsonic technical aerodynamics are centered about a 32″ × 45″ subsonic wind tunnel having a speed range extending from approximately 10 to 185 knots. The Structural Test Laboratory contains a testing machine of 200,000 pounds capacity, used in structural and stress analysis of aircraft components. The facilities of the Compressibility Laboratory include a transonic wind tunnel having a 4″ × 16″ test section and operating in the Mach number range from 0.4 to 1.4, and a supersonic wind tunnel having a 4″ × 4″ test section and operating in the Mach number range from 1.4 to 4. Instruments associated with these wind tunnels include a 9″ Mach-Zehnder interferometer and a 9″ and two 5″ Schlieren systems for flow observations. The Propulsion Laboratory contains a single test block and facilities for measurement of thrust, fuel flow, temperature, pressures and other parameters of engine operation. Present engine equipment consists of a 9½″ Westinghouse Turbo-Jet and three pulse jet engines. A small flame tube, especially equipped for the study of flame propagation, is also available.

For studies of flows in turbo machines the laboratory contains the Mark I Compressor Test Rig, instrumented for conventional performance measurements, and for special problems of three-dimensional flows about the stationary vanes and the turning rotor blades. By changing the angular position of the stationary vanes, a large number of design configurations can be investigated. Further, a small Boeing turboprop engine with variable pitch propeller is available for the determination of performance data and invesigations of transient control behavior. Under development is a 300 hp Cascade Test Rig for measurements of pressure distributions, and boundary layer investigations on blades of turbomachines.

The **Chemical** laboratories of the Department of Metallurgy and Chemistry are well equipped for instructional purposes at both the undergraduate and graduate level in chemistry and chemical engineering. These laboratories include a radiochemistry ("hot") laboratory with Geiger and scintillation counters and special apparatus for

handling and testing radioactive materials; a well-equipped fuel and lubricant laboratory; a plastics laboratory and shop where plastics are synthesized, molded in compression or injection presses, and their mechanical, physical and chemical properties determined; an explosives laboratory with impact tester, ballistics mortar, chronograph and other apparatus for evaluating explosives. Space is also available for faculty and student research projects.

The Metallurgy laboratories are completely equipped with the standard mechanical testing machines and heat-treating furnaces. The latest type of microscopes and metallographs are available for metallographic examination. Facilities for the study of crystal structures include X-ray diffraction units, powder cameras and heating cameras, Weissenberg X-ray goniometers and a recording photo densitometer. Metal fabricating and melting equipment include a swaging machine, rolling mill, induction and vacuum melting furnaces, a die-casting machine and a welding laboratory. Studies of the effect of high and low temperatures on metals are made in a laboratory equipped with creep testing apparatus and facilities for obtaining low temperatures.

In the **Electrical Engineering** laboratories, facilities are provided for instruction and research in servomechanisms, electronics, electrical machinery and circuits. The laboratories are equipped with many duplicate sets of equipment for performing all standard experiments. Additional items of special equipment include a five-unit harmonic set, a high-voltage set, a Schering Bridge, an analog computer, BTA motors, wave analyzers, sound meters, special servo analyzers, oscillographs, industrial analyzers, Brush recorders, dynamometers synchroscopes, amplidynes and rototrols.

The Electrical Engineering laboratories are housed in a specially designed two-story building (132′ x 132′) adjacent to the main engineering building. The ground floor houses the machinery and high voltage laboratories, and the second floor is devoted to electronics, control, servomechanisms and measurements. Both floors are provided with switchboards able to distribute a wide range of DC, AC 60-cycle or 400-cycle power to any location. The ground floor has a completely equipped darkroom and the upper floor an excellent standards laboratory, and twelve small research rooms.

The **Mechanical Engineering** laboratories provide facilities for instruction and research in elastic-body mechanics and dynamics, in hydromechanics and in heat-power and related fields. Noteworthy equipment in the heat-power laboratories include a forced-circulation boiler, 3500 psi and 1000°F; a gas or oil-fired boiler, 250 psi and 8000 lb./hr., fully automatic controls; a 150-HP Boeing turbo-prop gas turbine installation, dynamometer loaded; a two-dimensional supersonic air nozzle with schlieren equipment for analysis of shock-wise flows; a vapor-compression still and a solo-shell dual-effect evaporator. Facilities of the elastic-body mechanics and dynamics laboratories include a universal fatigue tester, for testing in tension, compression, bending or torsion, a Chapman polariscope for stress determination by photo-elastic method; vibration inducer units and associated equipment for inducing vibrations in mechanical systems with controlled amplitudes and frequencies from 20 to 20,000 cycles per second; Gisholt and Olsen dynamic balancing machines; and a linear accelerometer and calibrator unit.

The **Electronics** laboratories are well equipped for carrying on a comprehensive program of experimental work in the various branches of the field. Facilities are available for investigating the operational characteristics of radio and electronic circuits at frequencies ranging from d-c to the microwave region. For precision measurements and accurate calibration of instruments, standard frequency sources and standardizing equipment are available.

To illustrate modern communications practices, representative systems are available covering a wide range of operating frequencies, power outputs and methods of modulation. These include systems for transmitting manual and automatic telegraphy, voice and video signals. Additional systems include electronic countermeasures equipment, radio aids to navigation and a broad selection of Navy radar systems.

Improved facilities are now provided for the study of telemetering systems, computing systems, modern radar systems, antenna radiation characteristics, microwave phenomena, and transitors as well as for advanced work in circuit measurements. Additional space is also available for conducting individual research and project work.

The equipment of the **Mathematics and Mechanics** Department includes comprehensive computation facilities for use in the instruction and research program of the Engineering School. In addition to a general purpose automatically sequenced digital computer, the computing equipment now available includes an electronic analogue differential analyzer used to find the solution to a large class of differential equations; a specially modified accounting machine used in finite difference computations; a variety of planimeter type instruments including a large precision moment integrator, a Stieltjes integrator and a harmonic analyzer. The digital com-

puter is capable of magnetic storing of 1,000 numbers or instructions on a drum rotating at 40 r.p.s. and 100,000 numbers or instructions on a magnetic tape. It is used in the solution of thesis and other research problems as well as for instruction.

The laboratory facilities in Aerology include all instruments in present-day use for measuring the current physical and dynamic state of the atmosphere, as well as teletype and facsimile communications equipment for the rapid reception and dissemination of weather data in coded and analyzed form for the entire northern hemisphere.

The instruments for gathering weather data include Rawinsonde equipment, which provides a continuous recording of temperature, pressure, humidity and wind directions and velocities at designated levels above the surface; radiosonde equipment whereby pressure, temperature and humidity information is transmitted to ground via radio signals from heights that may extend above 100,000 feet; a wiresonde that measures air temperature and humidity conditions in the lower strata of the atmosphere, an inversion meter designed for remote recordings of free air temperature at designated heights in the boundary layer; a bathythermograph for recording sea temperature gradients; a weather configurated aircraft equipped as a flying classroom; and a shore wave recorder for measuring wave heights and periods.

TABLE I

CURRICULA GIVEN WHOLLY OR IN PART BY THE ENGINEERING SCHOOL

Curriculum	Group Desig.	Length	Cognizant Curricular Officer	Academic Associate
Advanced Science				
Chemistry	RC	3 yrs.	Engineering Electronics	Prof. Coonan
Mathematics (Applied)	RM	3 yrs.	Engineering Electronics	Prof. Church
Metallurgy	RMt	3 yrs.	Engineering Electronics	Prof. Coonan
Physics (General)	RP	3 yrs.	Engineering Electronics	Prof. Frey
Physics (Nuclear)	RX	3 yrs.	Engineering Electronics	Prof. Frey
Aerology	M	1 yr.	Aerology	Prof. Duthie
Aerology	MA	1½ yrs.	Aerology	Prof. Duthie
Advanced Aerology	MM	2 yrs.	Aerology	Prof. Duthie
Aeronautical Engineering				
Aerodynamics	AA	3 yrs.	Aeronautical Engineering	Prof. Coates
Aero-Hydrodynamics	AH	3 yrs.	Aeronautical Engineering	Prof. Coates
Electrical	AE	3 yrs.	Aeronautical Engineering	Prof. Vivell
Electrical	AE	2 yrs.	Aeronautical Engineering	Prof. Vivell
Flight Performance	AF	3 yrs.	Aeronautical Engineering	Prof. Higgins
General	AG	2 yrs.	Aeronautical Engineering	Prof. Coates
Guided Missiles and Armament Control	AM, AR	3 yrs.	Aeronautical Engineering	Prof. Thaler
Materials	AT	3 yrs.	Aeronautical Engineering	Prof. Coonan
Nuclear Propulsion	AN	3 yrs.	Aeronautical Engineering	Prof. Coonan
Propulsion Systems	AP	3 yrs.	Aeronautical Engineering	Prof. Kohler
Structures	AS	3 yrs.	Aeronautical Engineering	Prof. Coates
Command Communications	C	2 yrs.	Communications	Prof. Giet
Communications Engineering	CE	2 yrs.	Communications	Prof. Giet
Engineering Electronics (General)	E	2 yrs.	Engineering Electronics	Prof. Giet
Engineering Electronics (System Design)	EA	3 yrs.	Engineering Electronics	Prof. Giet
Engineering Electronics (Acoustics)	EW	3 yrs.	Engineering Electronics	Prof. Kinsler
Mine Warfare	RW	2 yrs.	Ordnance Engineering	Prof. Kinsler
Naval Engineering				
Chemical Engineering (Fuels and Lubricants)	NC	3 yrs.	Naval Engineering	Prof. Coonan
Electrical Engineering	NLA	3 yrs.	Naval Engineering	Prof. Polk
Gas Turbines	NJ	3 yrs.	Naval Engineering	Profs. Wright, Vavra
Mechanical Engineering	NH, NHA	2, 3 yrs.	Naval Engineering	Prof. Wright
Nuclear Power	NN	2 yrs.	Naval Engineering	Prof. C. D. G. King
Engineering Materials	NM	3 yrs.	Naval Engineering	Prof. Coonan
Petroleum Logistics	NS	2 yrs.	Naval Engineering	Prof. Coonan
Nuclear Engineering (Effects)	RZ	2 yrs.	Ordnance Engineering	Prof. Frey
Operations Analysis	RO	1½ yrs.	Ordnance Engineering	Prof. Cunningham
Ordnance Engineering				
Explosives and Propellants	OP	2 yrs.	Ordnance Engineering	Prof. Kinney
Fire Control	OF	3 yrs.	Ordnance Engineering	Prof. Bleick
General and Industrial	O	2 yrs.	Ordnance Engineering	Prof. Bleick
Guided Missiles and Aviation Ordnance	OG	2½ yrs.	Ordnance Engineering	Prof. Faulkner
Special Physics	OX	3 yrs.	Ordnance Engineering	Prof. Frey
Underwater Ordnance	OU	2 yrs.	Ordnance Engineering	Prof. Kinsler

TABLE II

CURRICULA CONDUCTED ENTIRELY AT OTHER INSTITUTIONS

Curriculum	Group Desig.	Length	Institution	Cognizant Curr. Officer	Liaison Official
Civil Engineering, Advanced Sanitary Engineering	ZGM	1 yr.	Michigan	Naval Engineering	C.O., NROTC Unit
Soil Mechanics & Foundations	ZGR	1 yr.	RPI	Naval Engineering	C.O., NROTC Unit
Structures	ZGI	1 yr.	Illinois	Naval Engineering	C.O., NROTC Unit
Waterfront Facilities	ZGP	1 yr.	Princeton	Naval Engineering	C.O., NROTC Unit
Civil Engineering, Qualification	ZGQ	17 mos.	RPI	Communications	C.O., NROTC Unit
Hydrographic Engineering	ZV	1 yr.	Ohio State	Aerology	C.O., NROTC Unit
Judge Advocate Officers Advanced Course	ZHV	9 mos.	Univ of Virginia	Communications	C.O., NROTC Unit
Management & Industrial Engineering	ZT	1 yr.	RPI	Naval Engineering	C.O., NROTC Unit
Metallurgical Engineering	ZNM	9 mos.	Carnegie Inst. of Tech.	Naval Engineering	Assoc. Prof. J. W. Ludewig
Naval Construction and Marine Engineering	ZNB	3 yrs.	Webb Inst.	Naval Engineering	Capt. R. A. Hinners USN (Ret.)
Naval Construction and Engineering	ZNB	3 yrs.	MIT	Naval Engineering	C.O., NavAdmin Unit
Naval Intelligence	ZI	9 mos.	U. S. Naval Intell. School, Wash.,D.C.	Staff Secretary	Director, U. S. Naval Intelligence School
Nuclear Engineering (Advanced)	ZNE	15 mos.	MIT	Naval Engineering	C.O., NavAdmin Unit
Oceanography	ZO	1 yr.	Univ. of Washington	Aerology	C.O., NROTC Unit
Personnel Administration and Training	ZP	1 yr.	Stanford	Communications	C.O., NROTC Unit
Petroleum Administration and Management (Gas, Oil and Water Rights)	ZHS	1 yr.	SMU	Communications	Senior Student
Petroleum Engineering	ZL	2 yrs.	Pittsburgh	Naval Engineering	Prof. H. G. Botset
Public Information	ZIB	1 yr.	Boston Univ.	Communications	C.O., NROTC Unit
Religion	ZU	1 yr.	Various	Communications	Various
Social Science	ZST	2 yrs.	Tufts Univ.	Communications	C.O., NROTC Unit
Special Mathematics	ZMI	2 yrs.	Illinois	Communications	C.O., NROTC Unit

NOTE: C. O. signifies the Commanding Officer.
An outline of each curriculum listed above is given on page 74 et seq.

THE ENGINEERING SCHOOL

Descriptive name of course is followed by two numbers, separated by a hyphen. The first number signifies classroom hours; the second, laboratory hours.

THE ACADEMIC LEVEL OF A COURSE IS INDICATED BY A LETTER IN PARENTHESES AFTER THE COURSE NUMBER AS FOLLOWS:

(A) Full graduate course

(B) Partial graduate course

(C) Undergraduate course

(L) Lecture course—no academic credit

One term credit-hour is given for each hour of lecture or recitation, and half of this amount for each hour of laboratory work. A term credit-hour is equivalent to two thirds of the conventional college semester credit hour because the Engineering School term is of ten-weeks duration in contrast to the usual college semester of 15 or 16 weeks.

ADVANCED MATHEMATICS

Officer students in any of the Engineering School curricula may, under special conditions, be afforded the opportunity to qualify for the degree of Master of Science with major in mathematics. This will require minor modifications, consistent with the objective of the officer's curriculum, designed to provide a working knowledge of one field of mathematics, a well-rounded background in three of the major fields of mathematics, and a well-founded study of some related field. Request for such modification should show that it is consistent with the objective of the officer student's curriculum and is of benefit to the Navy, and it must be approved by the Superintendent and the Chief of Naval Personnel.

1. To be eligible for this modification of curriculum the student should have passed one of the basic four-term engineering-mathematics sequences (e.g. Ma-120, Ma-121, Ma-122, Ma-123, Ma-124), or equivalent, with satisfactory grades (QPA of 2.0 or better). Courses in these sequences, designated as partial or whole graduate credit courses toward engineering degrees, will not be so considered in meeting the following requirements unless approved for such credit by the chairman of the department before commencing the course.

2. The required minimum of 48 term hours of courses at the graduate level will be distributed as nearly as practicable in the following way:

A. A minimum of 15 term hours of graduate credit in courses so chosen that not less than four term hours of graduate credit will be earned in each of three of the following branches of mathematics: a. algebra, b. geometry, c. analysis, and d. applied mathematics (statistics, probability, computational methods, game theory, etc.).

B. In addition to the above, two or more courses in the general subject chosen for specialization, carrying a total of not less than six term hours of graduate credit. It is expected that the thesis will be written on a topic in the field of this subject, and these courses may be taken fairly late in the curriculum.

C. A thesis, demonstrating the student's ability to locate and master with very little assistance the subject matter directly involved in the thesis topic, to organize it, to add to it if possible, and to present it systematically in appropriate literary, scientific, and scholarly form. The work on this project will, in general, be spread over two terms and receive eight term hours of graduate credit.

D. Not less than twelve graduate credit term hours in some related field which the candidate shall present as a minor.

3. The thesis director, topic, and subject of specialization shall be chosen, with the consent of the chairman of the department, as early as possible (but in all events, not later than two terms prior to the time for granting the degree). Minor departures from the preceding requirements may be authorized by the Chairman of the Department of Mathematics and Mechanics.

ADVANCED SCIENCE CURRICULA

Chemistry (Group Designator RC)
Metallurgy (Group Designator RM)
General Physics (Group Designator RP)
Nuclear Physics (Group Designator RX)
Applied Mathematics (Group Designator RM)

OBJECTIVE

To prepare selected officer personnel to deal with the problems of fundamental and applied research in the fields of general physics, nuclear physics, chemistry, metallurgy, and applied mathematics.

CURRICULA

Officers nominated for the Advanced Science Curricula are selected from among the first-year students enrolled in the Engineering School of the U. S. Naval Postgraduate School who apply for these curricula. Applicants are carefully screened and only those having a very good academic background and who appear to have an excellent chance of succeeding in their chosen field are nominated.

Officers in the Advanced Science Curricula complete the first year of their curriculum in the Engineering School at the U. S. Naval Postgraduate School. The second and third years are spent at a civilian university. These officers may spend the summer prior to entering the civilian universities on duty at the Office of Naval Research, Washington, D. C., familiarizing themselves with the work of the Office of Naval Research in the basic natural sciences, and preparing themselves for graduate school language requirements.

The curriculum at the civilian university for each officer is arranged from courses selected to suit the needs of the Navy, to develop the capabilities of the individual student and to meet the ultimate objective of his specialty.

The Advanced Science Curricula normally lead to the Master of Science degree for those officers meeting the requirements of the civilian universities for that degree and may, in exceptional cases for especially qualified officers, lead to a Doctor's degree.

AEROLOGY

(GROUP DESIGNATOR MA)

OBJECTIVE

To prepare officers to become qualified aerologists, with a working knowledge of oceanography as applied to naval operations.

FIRST YEAR (MA1)

FIRST TERM

Ma-161(C)	Algebra, Trigonometry, and Analytic Geometry	5-0
Mr-200(C)	Introduction to Meteorology	3-0
Mr-201(C)	Weather Codes and Elementary Weather Map Analysis	3-9
Ph-190(C)	Survey of Physics I	3-0
		14-9

SECOND TERM

Ma-162(C)	Introduction to Calculus	5-0
Mr-202(C)	Weather-Map Analysis	3-9
Mr-510(C)	Climatology	2-0
Ph-191(C)	Survey of Physics II	3-0
		13-9

THIRD TERM

Ma-163(C)	Calculus and Vector Analysis	4-0
Mr-203(C)	Upper-Air Analysis and Prognosis	2-9
Mr-301(B)	Elementary Dynamic Meteorology I	4-0
Mr-402(C)	Introduction to Meteorological Thermodynamics	3-2
LP-101(L)	NPS Lecture Program I	0-1
		13-12

FOURTH TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-204(C)	Weather Analysis and Forecasting	2-9
Mr-302(B)	Elementary Dynamic Meteorology II	3-0
Oc-120(B)	General Oceanography	4-0
LP-102(L)	NPS Lecture Program II	0-1
		13-12

During intersessional period students engage in synoptic laboratory work and visit naval and civilian installations.

SECOND YEAR (MA2)

FIRST TERM

Mr-215(B)	Advanced Weather Analysis and Forecasting	2-12
Mr-220(B)	Selected Topics in Applied Meteorology	4-0
Mr-403(B)	Introduction to Micro-meteorology	3-0
Mr-410(C)	Meteorological Instruments	2-2
Mr-610(B)	Sea and Swell Forecasting	2-2
		13-16

SECOND TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	3-0
Mr-216(B)	Advanced Weather Analysis and Forecasting	3-0
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-16
Oc-213(B)	Shallow-Water Oceanography	3-0
Oc-620(B)	Oceanography Factors in Underwater Sound	3-0
		12-16

The last group of students to be enrolled in this curriculum convened in August 1956.

AEROLOGY CURRICULA

AEROLOGY

(GROUP DESIGNATOR M)

OBJECTIVE

To prepare selected junior officers to become qualified for limited aerological duties.

FIRST YEAR (M1)

FIRST TERM

Ma-163(C)	Calculus and Vector Analysis	4-0
Mr-200(C)	Introduction to Meteorology	3-0
Mr-211(C)	Weather Codes, Maps, and Elementary Weather Map Analysis	2-12
Mr-400(C)	Introduction to Meteorological Instruments	2-0
Mr-402(C)	Introduction to Meteorological Thermodynamics	3-2
		14-14

SECOND TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-212(C)	Surface and Upper-Air Analysis	4-12
Mr-311(B)	Introduction to Dynamic Meteorology	5-0
		13-14

THIRD TERM

Mr-213(C)	Upper Air and Surface Prognosis	3-12
Mr-220(B)	Selected Topics in Applied Meteorology	4-0
Mr-403(B)	Introduction to Micro-meteorology	3-0
Mr-500(C)	Introduction to Climatology of the Oceans and Atmosphere	3-0
		13-12

FOURTH TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	3-0
Mr-205(C)	Forecasting Weather Elements and Operational Routines	4-0
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-20
Mr-610(B)	Sea and Swell Forecasting	2-2
		9-22

A certificate is awarded upon satisfactory completion of this curriculum.

AEROLOGY

(GROUP DESIGNATOR MM)

OBJECTIVE

To prepare officers to become qualified aerologists with a working knowledge of oceanography as applied to naval operations and to enable them through advanced study to devise and carry out aerological investigations.

The first year of this curriculum is effective for students entering in August 1957.

(FIRST YEAR MM1)

FIRST TERM

Ma-131(C)	Topics in Engineering Mathematics	5-2
Mr-200(C)	Introduction to Meteorology	3-0
Oc-110(C)	Introduction to Oceanography	3-0
Ph-196(C)	Review of General Physics	5-0
		16-2

SECOND TERM

Ma-132(B)	Vector Analysis and Differential Equations	5-0
Mr-201(C)	Weather Codes and Elementary Weather-Map Analysis	3-9
Mr-410(C)	Meteorological Instruments	2-2
Mr-413(B)	Thermodynamics of Meteorology	3-2
		13-13

THIRD TERM

Ma-133(A) Differential Equations and Vector Mechanics	5-0
Mr-202(C) Weather-Map Analysis	2-9
Mr-321(A) Dynamic Meteorology I	3-0
Mr-412(A) Physical Meteorology	3-0
Oc-210(B) Physical Oceanography	3-0
	16-9

FOURTH TERM

Ma-125(A) Numerical Methods for Digital Computers	2-2
Ma-330(C) Introduction to Statistics	2-0
Mr-203(C) Upper-Air Analysis and Prognosis	2-9
Mr-228(B) Southern Hemisphere and Tropical Meteorology	2-0
Mr-322(A) Dynamic Meteorology II	3-0
Oc-620(B) Oceanographic Factors in Underwater Sound	3-0
	14-11

During intersessional period students are instructed in the aerological aspects of ABC warfare and visit naval and civilian installations.

The second year of this curriculum is in effect for students now enrolled and will be revised for students entering in August 1957.

SECOND YEAR (MM2)

FIRST TERM

Ma-331(A) Statistics	4-2
Mr-215(B) Advanced Weather Analysis and Forecasting	2-9
Mr-322(A) Dynamic Meteorology II	3-0
Mr-412(A) Physical Meteorology	3-0
Oc-620(B) Oceanographic Factors in Underwater Sound	3-0
	15-11

SECOND TERM

Mr-216(B) Advanced Weather Analysis and Forecasting	3-0
Mr-217(B) Advanced Weather Analysis and Forecasting	0-16
Mr-229(B) Selected Topics in Meteorology	2-0
Mr-323(A) Dynamic Meteorology III	3-0
Mr-520(B) Applied Climatology	2-2
	10-18

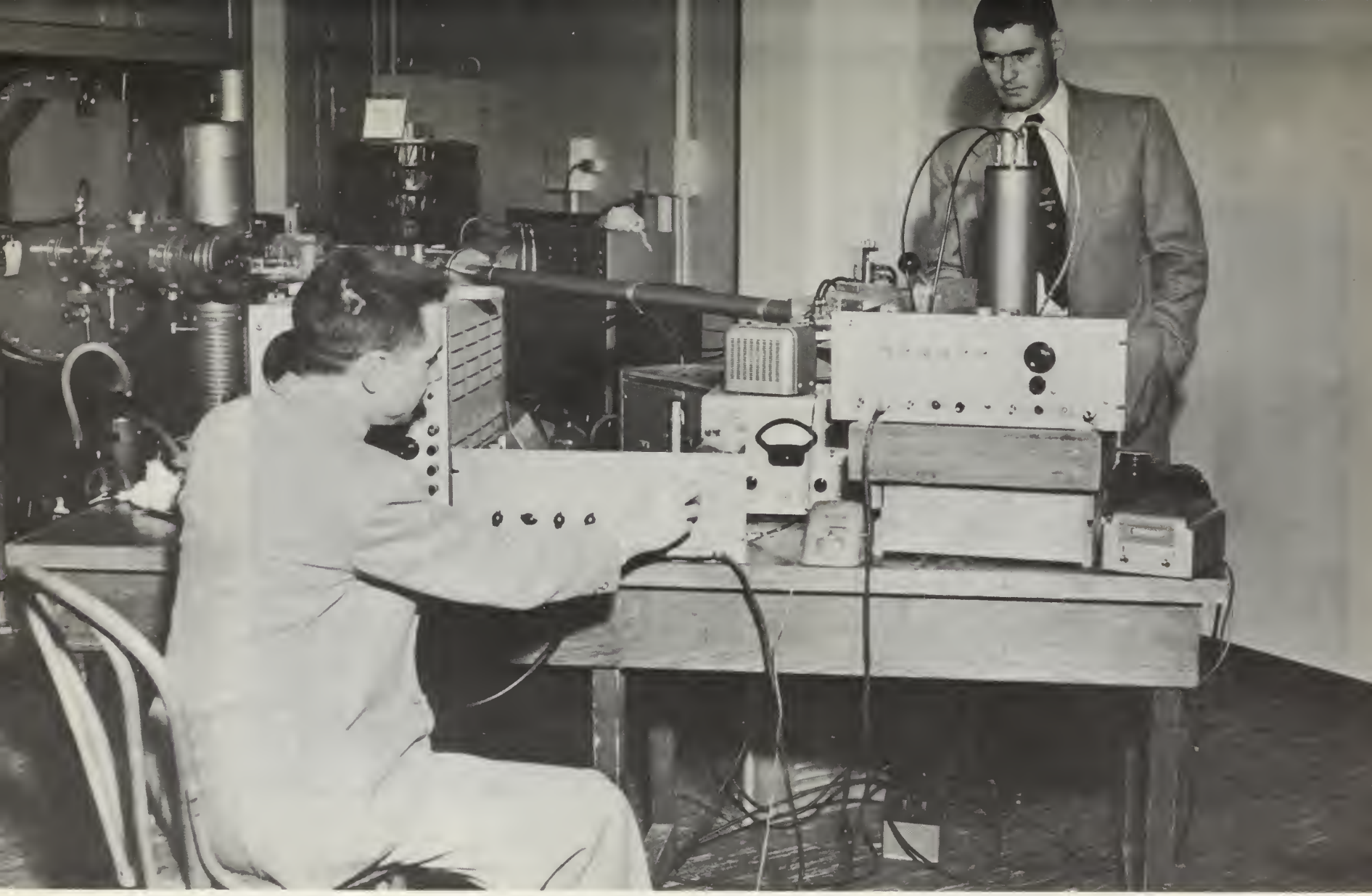
THIRD TERM

Ma-421(A) Digital and Analog Computation	3-2
Mr-110(C) Aerological Aspects of ABC Warfare	3-0
Mr-422(A) The Upper Atmosphere	5-0
Mr-610(B) Sea and Swell Forecasting	2-2
Thesis I	2-6
LP-101(L) NPS Lecture Program I	0-1
	15-11

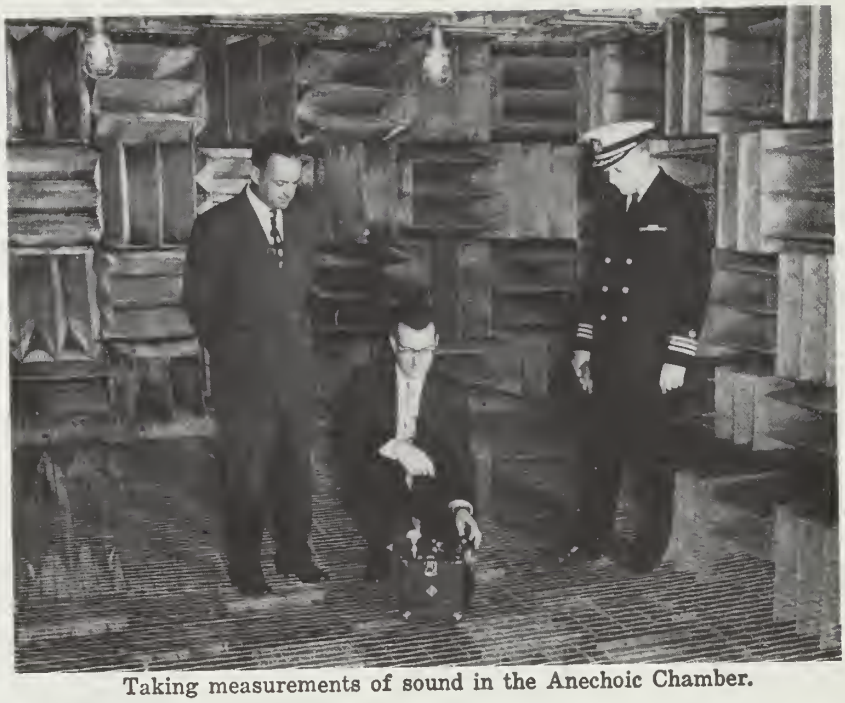
FOURTH TERM

Mr-218(B) Tropical Analysis and Forecasting	0-9
Mr-228(B) Southern Hemisphere and Tropical Meteorology	2-0
Mr-810(A) Seminar in Meteorology and Oceanography	2-0
Oc-213(B) Shallow-Water Oceanography	3-0
Thesis II	4-0
LP-102(L) NPS Lecture Program II	0-1
	11-10

This curriculum affords an opportunity to qualify for the degree of Master of Science in Aerology.



Students utilizing the two-million-volt Van de Graff nuclear accelerator, part of the physics laboratory equipment.



Taking measurements of sound in the Anechoic Chamber.

The electronic digital computer. This machine, like the analog computer, is used for computation connected with research projects, to support Mathematics Department courses in modern computing methods and for demonstrations by other departments. With such equipment, a great variety of complex problems, such as high-order differential equations, which would require several days by more conventional methods, can be solved in a few seconds.

AERONAUTICAL ENGINEERING

OBJECTIVE

To provide officers with advanced aeronautical engineering knowledge to meet the techical requirements of the Navy in this field. Specifically, these curricula are designed to cover the fundamental and advanced theories of mathematics, mechanics, metallurgy, structural analysis, aerodynamics, dynamics, aircraft propulsion, electricity and electronics as they concern the particular curriculum.

SUMMARY

Aeronautical engineering curricula comprise a basic group of two-year and three-year curricula, together with two less related curricula (Aeronautical Engineering, Electrical, and Aeronautical Engineering, Guided Missiles and Armament Control). The basic group share the first year and a half in common, and include a two-year curriculum in General Aerodynamics. Qualified volunteers from the basic curriculum will be selected in the middle of the second year for the three-year curricula, the last year being at a civilian engineering school (except Aeronautical Engineering, Materials). The last two terms at Monterey are modified slightly to provide preparation for these specialty studies. These third-year curricula provide emphasis in the aeronautical fields of Aerodynamics, Aero-hydrodynamics, Flight Performance, Materials, Nuclear Propulsion, Propulsion Systems, and Structures. Two-year and three-year curricula are offered at Monterey in Aeronautical Engineering, Electrical. Aeronautical Engineering, Guided Missiles and Armament Control, consists of two years at Monterey and a third year at a civilian institution. Satisfactory completion of two years at the Naval Postgraduate School normally leads to the award of a B.S. degree in Aeronautical Engineering. The three-year curricula afford opportunity to qualify for graduate degrees.

AERONAUTICAL ENGINEERING BASIC CURRICULUM

This common basic curriculum leads to the following specialties:

Two-Year Curriculum

Aeronautical Engineering, General _____(AG)

Three-Year Curricula

Aeronautical Engineering, Aerodynamics ____(AA)
Aeronautical Engineering, Aero-hydrodynamics _____(AH)
Aeronautical Engineering, Flight Performance _____(AF)
Aeronautical Engineering, Materials _____(AT)
Aeronautical Engineering, Nuclear Propulsion _____(AN)
Aeronautical Engineering, Propulsion Systems _____(AP)
Aeronautical Engineering, Structures _____(AS)

FIRST YEAR BASIC (A1)

FIRST TERM

Ae-200(C)	Rigid Body Statics	3-2
Ch-121 B)	General and Petroleum Chemistry	4-2
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		15-8

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Strength of Materials	4-0
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
Ae-001(L)	Aeronautical Lecture	0-1
		17-9

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ae-212(C)	Stress Analysis I	4-2
EE-111(C)	Fundamentals of Electrical Engineering	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
LP-101(L)	Lecture Program I	0-1
		16-9

FOURTH TERM

Ae-131(C)	Technical Aerodynamics, Performance I	4-2
Ae-213(B)	Stress Analysis II	4-2
Ae-409(C)	Thermodynamics I (Aeronautical)	4-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
ME-601(C)	Materials Testing Laboratory	0-2
LP-102(L)	Lecture Program II	0-1
		15-9

Note: Approximately four weeks of the intersessional period will be spent in the field at aviation activities.

AERONAUTICAL ENGINEERING, GENERAL

SECOND YEAR (AG-2)

FIRST TERM

Ae-132(B) Technical Aerodynamics, Performance II	3-2
Ae-311(C) Airplane Design I	2-4
Ae-410(B) Thermodynamics II (Aeronautical)	3-2
Ae-501(A) Hydro-Aero Mechanics I	4-0
	15-10

SECOND TERM

Ae-141(A) Aircraft Dynamics I	3-4
*Ae-151(B) Flight Testing and Evaluation I	2-0
*Ae-161(B) Flight Testing and Evaluation Laboratory I	0-4
Ae-411(B) Aircraft Engines	4-2
Ae-502(A) Hydro-Aero Mechanics II	4-0
Ae-001(L) Aeronautical Lecture	0-1
	13-11

*AGa substitute Ae 152 and Ae 162
AGp substitute:

Ae-412(B) Thermodynamics Lab	0-3
Ch-541(A) Reaction Motors	2-2

THIRD TERM

Ae-142(A) Aircraft Dynamics II	3-4
*Ae-152(B) Flight Testing and Evaluation II	2-0
*Ae-162(B) Flight Testing and Evaluation Laboratory II	0-4
Ae-421(B) Aircraft Propulsion	3-2
EE-611(B) Servomechanisms	3-4
Ma-321(B) Probability and Statistics	4-2
LP-101(L) Lecture Program I	0-1
	12-13

*AGa substitute Ch 541
AGp substitute Ae 151 and Ae 161

FOURTH TERM

[1] Ae-153(B) Flight Testing and Evaluation III	2-0
[1]*Ae-163(B) Flight Testing and Evaluation Laboratory III	0-8
Ae-508(A), Compressibility	3-2
EE-711(C) Electronics	3-2
Oa 121(B) Survey of Operations Analysis	3-0
LP-102(L) Lecture Program II	0-1
	11-13

*AGa substitute:

Ae-163(B) Flight Testing and Evaluation Laboratory III	0-4
Ae-428(A) Operating Principles of Turbomachines	3-2

[1] AGP substitute:

Ae-428(A) and	
Mt-302(A) High Temperature Metals	3-0

Note: Minor variations in the Aeronautical Engineering, General curriculum are indicated as follows: Auc (aerodynamics), AGf (flight performance) and AGp (propulsion).

Intersessional period: Course IE-102(C)—Elements of Management and Industrial Engineering at USNPS, Monterey.

AERONAUTICAL ENGINEERING BASIC THREE-YEAR CURRICULA

SECOND YEAR (A2)

FIRST TERM

Ae-132(B) Technical Aerodynamics, Performance II	3-2
Ae-311(C) Airplane Design I	2-4
Ae-410(B) Thermodynamics II (Aeronautical)	3-2
Ae-501(A) Hydro-Aero Mechanics I	4-0
Ma-115(A) Differential Equations for Automatic Control	3-0
	15-8

SECOND TERM

Ae-141(A) Aircraft Dynamics I	3-4
Ae-214(A) Stress Analysis III	3-0
Ae-312(B) Airplane Design II	1-4
Ae-411(B) Aircraft Engines	4-2
Ae-502(A) Hydro-Aero Mechanics II	4-0
Ae-001(L) Aeronautical Lecture	0-1
	15-11

*See Table I for Curricula Titles.

THIRD TERM

(AA-2, AF-2, AH-2*)

Ae-142(A)	Aircraft Dynamics	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ae-503(A)	Compressibility I	4-0
EE-241(C)	AC Circuits	3-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
LP-101(L)	Lecture Program I	0-1
		15-11

THIRD TERM

(AN-2*)

Ae-142(A)	Aircraft Dynamics II	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ch-541(A)	Reaction Motors	2-2
Mt-301(A)	High Temperature Materials	3-0
Ph 640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Lab	0-3
LP-101(L)	Lecture Program I	0-1
		14-12

THIRD TERM

(AP-2)

Ae-142(A)	Aircraft Dynamics II	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ae-503(A)	Compressibility I	4-0
Ch-541(A)	Reaction Motors	2-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
LP-101(L)	Lecture Program I	0-1
		14-11

THIRD TERM

(AS-2*)

Ae-142(A)	Aircraft Dynamics II	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ae-508(A)	Compressibility	3-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
LP-101(L)	Lecture Program I	0-1
		11-11

FOURTH TERM

(AA-2, AF-2, AH-2*)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-504(A)	Compressibility II	3-2
EE-711(C)	Electronics	3-2
Ma-421(A)	Digital and Analog Computation	3-2
Mc-311(A)	Vibrations	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		16-10

FOURTH TERM

(AN-2*)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-508(A)	Compressibility	3-2
Ch-561(A)	Physical Chemistry	3-2
*Mc-311(A)	Vibrations	3-2
*Ph-642(B)	Nuclear Physics	4-0
LP-102(L)	Lecture Program II	0-1
		17-8

*ORSORT candidates substitute

ME-310	Heat Transfer	4-2

FOURTH TERM

(AP-2)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-504(A)	Compressibility II	3-2
Ch-581(A)	Chemistry of Special Fuels	2-2
Ma-421(A)	Digital and Analog Computation	3-2
Mc-311(A)	Vibrations	3-2
LP-102(L)	Lecture Program II	0-1
		15-10

FOURTH TERM

(AS-2*)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-215(A)	Advanced Stress Analysis	4-0
Ma-421(A)	Analog and Digital Computation	3-2
Mc-311(A)	Vibrations	3-2
Me-622(B)	Experimental Stress Analysis	2-2
LP-102(L)	Lecture Program II	0-1
		16-8

*See Table I for Curricula Titles.

Intersessional period: Course IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

THIRD YEAR CURRICULA

SECOND AND THIRD YEARS (A2 AND A3) AT THE COLLEGE OF AERONAUTICS, CRANFIELD, ENGLAND

At the end of the first year of work in the A curriculum at the Postgraduate School certain students may be selected for study at the College of Aeronautics. Students selected may choose a curriculum from the following options:

Aerodynamics
Aircraft Design
Aircraft Propulsion
Aircraft Economics and Production
Aircraft Electronics

Aeronautical Engineering, Aerodynamics

THIRD YEAR (AA3) AT CALIFORNIA INSTITUTE OF TECHNOLOGY

Ae-110 Systems Concepts in Engineering
Ae-200 Research in Aeronautics
Ae-201 Hydrodynamics of Compressible Fluids
Ae-203 Advanced Problems in Aerodynamics
Ae-204 Aerodynamics of Real and Perfect Fluids
Advanced Seminar

THIRD YEAR (AA3) AT UNIVERSITY OF MICHIGAN

FALL TERM

AE 119 Intermediate Aerodynamics
AE 142 Mechanics of Flight II
AE 160 Seminar I
AE 161 Thesis
AE 164 Aircraft Propulsion II
AE 210 Dynamics of Viscous Fluids

SPRING TERM

AE 143 Methods in Airplane Dynamics
AE 144 Aeroelasticity in Airplane Dynamics
AE 150 Rotary Wing Aircraft
AE 160 Seminar II
AE 161 Thesis
AE 202 Dynamics of Compressible Fluids

THIRD YEAR (AA3) AT UNIVERSITY OF MINNESOTA

FALL TERM

Ae-107 Aerodynamics of Viscous Fluids
*Ae-116 Advanced Airplane Stresses
*Ae-201 Aerodynamics of Compressible Fluid
Ae-204 Supersonic Aerodynamics Laboratory
Ae-280 Thesis

WINTER TERM

Ae-117 Dynamics of Aircraft Structures
Ae-202 Compressible Fluids
Ae-220 High Speed Performance and Design
Ae-280 Thesis

SPRING TERM

Ae-118 Stresses on Aircraft Structures
Ae-203 Compressible Fluids
Ae-280 Thesis

*Candidates having adequate prerequisites omit Ae-116 or Ae-201.

Aeronautical Engineering, Flight Performance

THIRD YEAR (AF3) AT PRINCETON UNIVERSITY

FALL TERM	SPRING TERM
AE-561 Aeroelasticity	AE-566 Airplane Dynamics
AE-565 Airplane Dynamics	AE-594 Advanced Stability and Control
AE-567 Helicopter Analysis I	*AE-562 Aeroelasticity
AE-593 Advanced Airplane Performance	*AE-568 Helicopter Analysis II
Thesis	*EE-518 Servomechanisms
AE-595 Flight Test Instrumentation	*Instrumentation Seminar
*Elect any two.	Thesis

Aeronautical Engineering, Aero-Hydrodynamics

THIRD YEAR (AH3) AT STEVENS INSTITUTE OF TECHNOLOGY

FALL TERM	SPRING TERM
ME-273 Aerolasticity	ME-274 Aerolasticity
FD-279 Mechanics of Compressible Fluids	FD-280 Subsonic and Supersonic Fluid Dynamics
FD 286 Experimental Methods in Hydrodynamics	FD-288 Hydrodynamic Design of Seaplanes II
FD-287 Hydrodynamic Design of Seaplanes I	FD-400 Special Problems in Hydrodynamics II
FD-400 Special problems in Hydrodynamics I	FD-500 Thesis
FD-500 Thesis	

This curriculum is subject to further revision when a sufficient number of students makes presentation of certain specialized courses possible.

Aeronautical Engineering, Materials

THIRD YEAR (AT3) AT NAVAL POSTGRADUATE SCHOOL

Curriculum not yet formulated.

Aeronautical Engineering, Propulsion Systems

THIRD YEAR (AP3) AT UNIVERSITY OF MICHIGAN

FALL TERM

AE-119 Intermediate Aerodynamics
AE-142 Mechanics of Flight II
AE-161 Thesis
AE-164 Aircraft Propulsion II

SPRING TERM

AE-161 Thesis
AE-166 Aircraft Propulsion Laboratory
AE-167 Aircraft Propulsion III
AE-261 Gas Dynamics
AE-262 Combustion and Flame Propagation
*AE-172 Engineering Measurements and Instrumentation
*NE-190 Introduction to Nuclear Engineering
*Electives

THIRD YEAR (AP3') AT CALIFORNIA INSTITUTE OF TECHNOLOGY

Ae-201 Hydrodynamics of Compressible Fluids
JP-280 Research in Jet Propulsion
JP-121 Rockets
JP-130 Thermal Jets
JP-200 Chemistry Problems in Jet Propulsion Advanced Seminar

THIRD YEAR (AP3) AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FALL TERM

2.213 Gas Turbines
16.105 Applied Aerodynamics
Thesis
* 2.82 Combustion
* 2.49 Advanced Fluid Mechanics
* 2.521 Advanced Heat Transfer
*10.311 Heat Transfer
*Electives

SPRING TERM

2.214 Gas Turbines
16.56 Jet Propulsion Engines
Thesis
* 2.212 Advanced Mechanics
* 2.491 Compressible Fluid Mechanics
* 2.522 Advanced Heat Transfer
* 3.44 Behavior of Metals at Elevated Temperatures

THIRD YEAR (AP3) AT UNIVERSITY OF MINNESOTA

FALL TERM

*AE-116 Advanced Airplane Stresses
*AE-201 Aerodynamics of Compressible Fluids
ME-252 Advanced Reciprocating Engines
AE-204 Supersonic Aerodynamics Laboratory
Thesis

WINTER TERM

AE-117 Dynamics of Aircraft Structures
AE-202 Compressible Fluids
ME-253 Advanced Gas Turbines
Thesis

SPRING TERM

AE-118 Stresses on Aircraft Structures
ME-255 Thermal Jets and Rockets
Thesis

*Candidates having adequate prerequisites omit AE-116 or AE-201.

Aeronautical Engineering, Nuclear Propulsion

THIRD YEAR (AN3) AT IOWA STATE COLLEGE

FALL TERM

Chem-408 Nuclear and Radiochemistry
Engg-501 Elements of Nuclear Engineering
Engg-620 Seminar
Engg-600 Research
Lib-614 Bibliographical Research
M.E.-646 Advanced Heat Transfer
Phys-435 Nuclear Physics for Engineers

WINTER TERM

Engg.-502 Reactor Materials and Structures
Phys.-346 Nuclear Physics for Engineers
Chem.-529 Radiochemistry
*Engg.-600 Research

SPRING TERM

Engg.-503 Reactor Fuels and Wastes
Engg.-504 Reactor Design
Engg.-600 Research (Thesis)

*Physics-422 (Quantum Mechanics) may be substituted for three credits of Engg.-600.

FIRST HALF OF THIRD YEAR (AN3) AT NAVAL POSTGRADUATE SCHOOL

FIRST TERM

CH-551(A) Radiochemistry	2-2
Ph-540(B) Kinetic Theory and Statistical Mechanics	3-0
ME-900(A) Problems in Mechanical Engineering	3-0
PH-643(B) Nuclear Physics Lab	0-3
Thesis	0-8
	10-15

SECOND TERM

Ch-553(A) Nuclear Chemical Tech	4-3
Ph-651(A) Reactor Theory	3-0
Thesis	0-14
	7-17

LAST HALF OF THIRD YEAR (AN3) AT OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY

SPRING TERM

Reactor Analysis
Reactor Chemical Technology
Reactor Components Technology
Reactor Engineering Science
Reactor Instrumentation & Controls
Experimental Reactor Physics
Reactor Materials
Reactor Shielding
Reactor Systems

Aeronautical Engineering, Structures

THIRD YEAR (AS3) AT UNIVERSITY OF MICHIGAN

AE-119 Intermediate Aerodynamics
AE-131 Aircraft Structures II
AE-142 Mechanics of Flight II
AE-160 Seminar I
AE-161 Thesis
AE-164 Aircraft Propulsion II
AE-133 Aircraft Structures III
AE-134 Materials and Structures
AE-144 Aeroelasticity in Airplane Dynamics
AE-150 Rotary Wing Aircraft
AE-160 Seminar II
AE-161 Thesis

THIRD YEAR (AS3) AT CALIFORNIA INSTITUTE OF TECHNOLOGY

Ae-110 Systems Concepts in Aeronautics
Ae-200 Research in Aeronautics
Ae-107 Elasticity Applied to Aeronautics
AE-202 Advanced Problems in Solid Mechanics
Ae-207 Aeroelasticity
Advanced Seminar

THIRD YEAR (AS3) AT UNIVERSITY OF MINNESOTA

FALL TERM

*Ae-116 Advanced Airplane Stresses
*Ae-201 Aerodynamics of Compressible Fluids
Ae-240 Dynamics of Airplane Structures
Ae-280 Thesis

WINTER TERM

Ae-117 Advanced Airplane Stresses
Ae-202 Compressible Fluids
Ae-241 Dynamics of Aircraft
Ae-280 Thesis

SPRING TERM

Ae-118 Stresses in Aircraft Structures
Ae-204 Supersonic Aerodynamics Laboratory
Ae-119 Structural Test of Aircraft
Ae-280 Thesis

*Candidates having adequate prerequisites omit Ae-116 or Ae-201.

AERONAUTICAL ENGINEERING, GUIDED MISSILES AND ARMAMENT CONTROL

(GROUP DESIGNATOR AR or AM)

The curriculum consists of two-years study at the Postgraduate School and a third year of study at civilian educational institutions. This curriculum covers electrical, aeronautical, and mechanical engineering subjects and related mathematics, metallurgy, and electronics courses. The third year offers specialization in airborne weapons control at MIT, or guided missiles control and guidance at Univ. of Mich. These third-year specializations offer the opportunity to qualify for a graduate degree.

FIRST YEAR (AR1 and AM1)

FIRST TERM

Ae-200(C)	Rigid Body Statics	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Strength of Materials	4-0
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		17-9

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ae-212(C)	Stress Analysis I	4-2
EE-463(C)	Transformers and Special Devices	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
LP-101(L)	Lecture Program I	0-1
		16-9

FOURTH TERM

Ae-136(B)	Aircraft Performance	3-2
Ae-213(B)	Stress Analysis II	4-2
Ae-409(C)	Thermodynamics I (Aero)	4-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
LP-101(L)	Lecture Program II	0-1
		16-9

Intersessional period: four weeks will be spent in the field at aviation activities.

SECOND YEAR (AR2 and AM2)

FIRST TERM

Ae-316(C) Airplane Design	2-4
Ae-410(B) Thermodynamics II (Aero)	3-2
Ae-501(A) Hydro-Aero Mechanics I	4-0
EE-551(B) Transmission Lines and Filters	3-2
Ma-115(A) Differential Equations for Automatic Control	3-0
	15-8

SECOND TERM

Ae-502(A) Hydro-Aero Mechanics II	4-0
EE-771(B) Electronics	3-2
Ma-125(B) Numerical Methods for Digital Computers	2-2
Mc-311(A) Vibrations	3-2
Mc-402(A) Mechanics of Gyroscopic Instruments	3-0
Ae-001(L) Aeronautical Lecture	0-1
	15-7

THIRD TERM

Ae-146(C) Aircraft Dynamics	3-2
Ae-508(A) Compressibility	3-2
EE-671(A) Transients	3-4
EE-772(B) Electronics	3-2
Mc-401(A) Exterior Ballistics	3-0
LP-101(L) Lecture Program I	0-1
	15-11

FOURTH TERM

EE-745(A) Electronic Control and Measurement	3-3
EE-672(A) Servomechanisms	3-3
Ma-421(A) Analog and Digital Computation	3-2
*Ph-240(C) Geometrical and Physical Optics	3-3
LP-102(L) Lecture Program II	0-1
	12-12

*(AM2) Substitute:
Ma-301(B) Statistics 3-2

Intersessional period: Course IE-102(C)—Elements of Management and Industrial Engineering at USNPS, Monterey.

Aeronautical Engineering, Guided Missiles and Armament Control

THIRD YEAR (AR3) AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FALL TERM

16.15 Advanced Stability and Control of Aircraft
16.33 Instrumentation and Control Laboratory
16.39 Vector Kinematics and Gyroscopic Instrument Theory
16.41 Fire Control Principles
16.472 Rockets, Guided Missiles and Projectiles Thesis

SPRING TERM

16.42 Fire Control Systems
16.44 Advanced Fire Control Instrument Laboratory
16.40 Automatic Control Equipment for Aircraft Thesis

THIRD YEAR (AM3) AT UNIVERSITY OF MICHIGAN

FALL TERM

Ae-119 Intermediate Aerodynamics
Ae-142 Mechanics of Flight II
Ae-161 Thesis
Ae-248 Advanced Feedback Control
Ae-250 Theory of Oscillation of Nonlinear Systems
Ae-252 Seminar of Simulation and Solution of Nonlinear Systems

SPRING TERM

Ae-102 Advanced Design
Ae-161 Thesis
*Ae-164 Aircraft Propulsion II
Ae-214 Control and Guidance of Pilotless Aircraft
Ae-273 Variant Nonolinear Systems
*Electives

AERONAUTICAL ENGINEERING, ELECTRICAL

GROUP DESIGNATOR (AE)

This curriculum consists of two-years study at the Naval Postgraduate School. Selected students will continue for a third year of study at the Naval Postgraduate School. This curriculum is designed to provide major emphasis on electricity and is supported by aeronautics, mathematics, metallurgy, electronics, and mechanics. The objective of this curriculum is to provide electrical engineers who will have a good understanding of aeronautical engineering.

FIRST YEAR (AE1)

FIRST TERM

Ae-200(C)	Rigid Body Statics	3-2
EE-171(C)	Electric Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Strength of Materials	4-0
EE-271(C)	Alternating-Current Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		17-9

THIRD TERM

Ae-121(C)	Technical Aerodynamics I	3-2
Ae-212(C)	Stress Analysis I	4-2
EE-272(B)	Alternating-Current Circuits	2-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
LP-101(L)	Lecture Program I	0-1
		15-9

FOURTH TERM

Ae-136(B)	Aircraft Performance	3-2
Ae-213(B)	Stress Analysis II	4-2
EE-371(C)	Direct-Current Machinery	3-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
LP 102	Lecture Program II	0-1
		16-9

Intersessional period: four weeks will be spent in the field at aviation activities.

SECOND YEAR (AE2)

FIRST TERM

Ae-311(C)	Aircraft Design	2-4
Ae-501(A)	Hydro-Aero Mechanics I	4-0
EE-471(C)	Alternating-Current Machinery	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
Ma-125(B)	Numerical Methods for Digital Computers	2-2
		14-10

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-472(C)	Alternating-Current Machinery	3-4
EE-971(A)	Seminar	1-0
Ma-421(A)	Analog and Digital Computation	3-2
Mc-311(A)	Vibrations	3-2
Ae-001(L)	Aeronautical Lecture	0-1
		14-9

THIRD TERM

Ae-146(A) Aircraft Dynamics	3-2
Ae-508(A) Compressibility	3-2
EE-671(A) Transients	3-4
EE-771(B) Electronics	3-2
EE-971(A) Seminar	1-0
IT-101(L) Industrial and Technical Technical Lectures I	0-1
	13-11

FOURTH TERM

Ch-521(A) Plastics	3-2
EE-672(A) Servomechanisms	3-3
EE-772(B) Electronics	3-2
EE-971(A) Seminar	1-0
EE-745(A) Electronic Control and Measurement	3-3
IT-102(L) Industrial and Technical Lectures II	0-1
	13-8

Intersessional period: Course IE-101(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

THIRD YEAR (AE3)

FIRST TERM

EE-571(B) Transmission Lines and Filters	3-4
EE-871(A) Electrical Machine Design	4-0
Es-267(A) Electron Tubes and UHF Techniques	3-2
Es-326(A) Radio Systems	3-3
Thesis	0-3
	13-12

SECOND TERM

EE-872(A) Electrical Machine Design	4-0
EE-971(A) Seminar	1-0
Es-461(A) Pulse Techniques	3-3
Thesis	0-10
	8-13

THIRD TERM

EE-873(A) Electrical Machine Design	4-0
EE-971(A) Seminar	1-0
Es-422(B) Radar System Engineering	3-3
Thesis	0-10
	8-13

FOURTH TERM

EE-874(A) Electrical Machine Design	4-0
EE-971(A) Seminar	1-0
Es-423(B) Radar System Engineering	3-6
Es-536(B) Countermeasures	2-3
Thesis	0-6
	10-15

This curriculum affords an opportunity to qualify for the degree of Master of Science in Electrical Engineering.

CHEMICAL ENGINEERING (FUELS AND LUBRICANTS) CURRICULUM

(GROUP DESIGNATOR NC)

OBJECTIVE

To educate officers in the chemistry, properties, applications, and inspection of fuels and lubricants.

FIRST YEAR (NC1)

FIRST TERM

Ma-100(C) Vector Algebra & Geometry	2-1
Ma-111(C) Introduction to Engineering Mathematics	3-1
Mc-101(C) Engineering Mechanics	2-2
Ch-101(C) General Inorganic Chemistry	3-2
Cr-301(B) Crystallography & Mineralogy	3-4
	13-10

SECOND TERM

CE-111(A) Fuel & Oil Chemistry	2-2
Ma-112(B) Differential Equations and Infinite Series	5-0
Ge-401(C) Petrology & Petrography	2-3
Mt-201(C) Introductory Physical Metallurgy	3-2
Mc-102(C) Engineering Mechanics	2-2
	14-9

THIRD TERM

Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
CE-521(A) Plastics	3-2
Mt-208(C) Physical and Production Metallurgy	4-2
CE-611(C) Thermodynamics (Ch Eng)	3-2
Ch-221(C) Qualitative Analysis	3-2
	16-8

FOURTH TERM

ME-111(C) Engineering Thermodynamics	4-2
ME-511(C) Strength of Materials	5-0
Ch-231(C) Quantitative Analysis	2-4
Ma-114(A) Functions of a Complex Variable & Vector Analysis	3-0
ME-602(C) Materials Testing Lab	0-2
	14-8

Interessional period: IE-101(C) Elements of Management and Industrial Engineering, will be taken at USNPS, Monterey.

SECOND YEAR (NC2)

FIRST TERM

ME-112(B) Engineering Thermodynamics	4-2
ME-421(C) Hydromechanics	3-2
ME-522(B) Strength of Materials	4-0
CE-701(C) Chemical Engineering Calculations	3-2
Ch-311(C) Organic Chemistry	3-2
	17-8

SECOND TERM

ME-711(B) Mechanics of Machinery	4-2
ME-422(B) Hydromechanics	2-2
ME-211(C) Marine Power Plant Equipment	3-2
Ch-312(C) Organic Chemistry	3-2
	12-8

THIRD TERM

ME-212(C) Marine Power Plant Equipment	3-4
CE-721(B) Unit Operations	3-0
Ch-411(C) Physical Chemistry	3-2
ME-712(A) Dynamics of Machinery	3-2
	12-8

FOURTH TERM

Ch-412(C) Physical Chemistry	3-2
ME-223(B) Marine Power Plant Analysis	2-4
ME-820(C) Machine Design	2-4
ME-310(B) Heat Transfer	4-2
	11-12

Intersessional period: A field trip will be arranged in the Petroleum Industry.

CHEMICAL ENGINEERING (FUELS AND LUBRICANTS) CURRICULUM

THIRD YEAR (NC3)

FIRST TERM

Mt-301(A)	High Temperature Materials	3-0
CE-722(A)	Unit Operations	3-0
Mt-203(B)	Physical Metallurgy	2-2
CE-612(C)	Thermodynamics	3-2
ME-217(C)	Internal Combustion Engines	3-2
		14-6

SECOND TERM

Ph-610(B)	Atomic Physics	3-0
GE-101(C)	Physical Geology	3-2
Ch-413(A)	Physical Chemistry	2-2
CE-613(A)	Chemical Engineering Thermodynamics	3-2
	Thesis	0-4
		11-10

THIRD TERM

CE-731(A)	Petroleum Refinery Engineering	3-0
GE-241(C)	Geology of Petroleum	2-4
Ch-800(A)	Petroleum Seminar	2-0
	Thesis	0-10
		7-14

FOURTH TERM

Ch-732(A)	Petroleum Refining Engineering	3-0
Ch-800(A)	Petroleum Seminar	2-0
ME-240(B)	Nuclear Power Plants	4-0
	Thesis	0-10
		9-10

This curriculum affords the opportunity to qualify for the degree of Master of Science.

COMMAND COMMUNICATIONS

(GROUP DESIGNATOR C)

OBJECTIVE

To prepare officers for communication, operations and staff duties, and to better fit them for command.

This curriculum majors in practical communications, operations, tactics, electronics, administration and management.

FIRST YEAR

The first year is spent at the General Line School.

SECOND YEAR

FIRST TERM

Co-101(C)	Communication Principles and Procedures	3-2
Co-101a(C)	Typing and Operating Procedures	0-2
Co-111(C)	Communications-Electronics Security	2-0
Co-141(C)	Public Speaking	0-1
Co-121(C)	Commercial Communications	2-0
Es-281(C)	Electronics Fundamentals and Circuit Theory	4-3
Ma-162(C)	Introduction to Calculus	5-0
		16-8

SECOND TERM

Co-102(C)	Communication Principles and Procedures	2-2
Co-112(C)	Communications-Electronics Security	1-1
Co-142(C)	Public Speaking	0-1
Co-162(C)	Naval Fiscal Management	2-0
Es-282(C)	Electron Tubes and Circuits	4-3
Es-786(C)	RF Energy Transmission	4-2
Ma-320(C)	Introduction to Statistics and Operations Analysis	4-0
		17-9

THIRD TERM

Co-113(C)	Cryptographic Methods and Procedures	0-3
Co-123(C)	Communications Planning	3-2
Es-284(C)	Transistors and Transistor Circuits	3-3
Es-386(C)	Transmitters and Receivers	3-3
Es-387(C)	Pulse Techniques and Pulse Modulation	3-3
IT-101(L)	Industrial and Technical Lectures I	0-1
		12-15

FOURTH TERM

Co-114(C)	Cryptographic Methods and Procedures	0-3
Co-124(C)	Communications Planning	3-2
Co-154(C)	Communications Seminar	0-2
Co-164(C)	Administration and Management	3-0
Es-586(C)	Special Systems I	4-3
Es-587(C)	Special Systems II	4-3
IT-102(L)	Industrial and Technical Lectures II	0-1
		14-14

A certificate is awarded upon satisfactory completion of this course.

COMMUNICATIONS ENGINEERING

(GROUP DESIGNATOR CE)

OBJECTIVE

To prepare unrestricted line officers for important assignments afloat and ashore in operations and naval communications. It majors in communications electronics and leads to a Baccalaureate Communication Engineering degree.

This curriculum is currently under development and no description of the curriculum is included in the catalogue.

ELECTRICAL ENGINEERING

(GROUP DESIGNATOR NLA)

OBJECTIVE

To prepare officers in advanced electrical engineering for technical and administrative duties connected with naval machinery and engineering plants.

FIRST YEAR

FIRST YEAR (NLA1)

FIRST TERM

Ch-121(B) General and Petroleum Chemistry	4-2
EE-171(C) Electrical Circuits and Fields	3-4
Ma-100(C) Vector Algebra and Geometry	2-1
Ma-111(C) Introduction to Engineering Mathematics	3-1
Mc-101(C) Engineering Mechanics I	2-2
	14-10

SECOND TERM

EE-271(C) Alternating-Current Circuits	3-2
Ma-112(B) Differential Equations and Infinite Series	5-0
Mc-102(C) Engineering Mechanics II	2-2
ME-500(C) Strength of Materials	3-0
Mt-201(C) Introductory Physical Metallurgy	3-2
	16-6

THIRD TERM

EE-272(B) Alternating-Current Circuits	2-2
EE-273(C) Electrical Measurement I	2-3
Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-201(A) Methods in Dynamics	2-2
Mt-208(C) Physical and Production Metallurgy	4-2
LP-101(L) NPS Lecture Program I	0-1
	13-10

FOURTH TERM

EE-371(C) Direct-Current Machinery	3-2
Ma-114(A) Functions of a Complex Variable and Vector Analysis	3-0
ME-111(C) Engineering Thermodynamics	4-2
ME-601(C) Materials Testing Laboratory	0-2
Mt-301(A) High Temperature Materials	3-0
LP-102(L) NPS Lecture Program II	0-1
	13-7

Intersessional period: Course IE-101(C) Elements of Management and Industrial Engineering at USNPS, Monterey.

SECOND YEAR (NLA2)

FIRST TERM

EE-274(B) Electrical Measurements II	2-3
EE-471(C) Alternating-Current Machinery	3-4
Ma-115(A) Differential Equations for Automatic Control	3-0
ME-122(C) Engineering Thermodynamics	3-2
Ma-125(B) Numerical Methods for Digital Computers	2-2
	13-11

SECOND TERM

EE-472(C) Alternating-Current Machinery	3-4
EE-971(A) Seminar	1-0
ME-421(C) Hydromechanics	3-2
Ma-421(A) Digital and Analog Computation	3-2
Ph-610(B) Survey of Atomic and Nuclear Physics	3-0
	13-8

THIRD TERM

EE-571(B) Transmission Lines and Filters	3-4
EE-771(B) Electronics	3-2
EE-971(A) Seminar	1-0
EE-671(A) Transients	3-4
Ph-361(A) Electromagnetism	3-0
LP-101(L) NPS Lecture Program I	0-1
	13-11

FOURTH TERM

EE-672(A) Servomechanisms	3-3
EE-971(A) Seminar	1-0
EE-772(B) Electronics	3-2
ME-310(B) Heat Transfer (or elective)	4-2
Ph-362(A) Electromagnetic Waves	3-0
LP-102(L) NPS Lecture Program II	0-1
	14-8

Intersessional period: A four- or five-week field trip will be arranged in the electrical manufacturing industry.

THIRD YEAR (NLA3)

FIRST TERM

EE-745(A)	Electronic Control and Measurement	3-3
EE-871(A)	Electrical Machine Design	4-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
	Thesis	0-6
		9-11

SECOND TERM

EE-872(A)	Electric Machine Design	4-0
EE-971(A)	Seminar	1-0
ME-221(C)	Marine Power Plant Equipment	3-2
	Thesis	0-12
		8-14

THIRD TERM

EE-873(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
ME-222(C)	Marine Power Plant Equipment	3-4
LP-101(L)	NPS Lecture Program I	0-1
	Thesis	0-12
		8-17

FOURTH TERM

EE-874(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
LP-102(L)	NPS Lecture Program II	0-1
	Thesis	0-8
		11-13

This curriculum affords the opportunity to qualify for the degree of Master of Science in Electrical Engineering.

ENGINEERING ELECTRONICS

OBJECTIVE

To educate officers in the basic sciences and technical fields related to electronics in order to better equip them to handle electronics problems ashore and afloat. The basic curriculum consists of two years of study at the Naval Postgraduate School. Two advanced curricula are available, within quota limitations, to qualified volunteers who are in the restricted line or who intend to transfer to the restricted line. One specializes in underwater acoustics and the other in systems design and both consist of three years of study at the Postgraduate School in Monterey. Satisfactory completion of the General curriculum normally leads to the B.S. degree in Engineering Electronics and the three year curricula afford an opportunity to qualify for an M.S. degree.

TWO-YEAR CURRICULUM (GENERAL)

(GROUP DESIGNATOR E)

OBJECTIVE

To further the aims of the basic objective by giving officer students a fundamental course in engineering electronics in order that intelligent understanding of the fields of electronics may be obtained.

FIRST YEAR (E1)

FIRST TERM

Es-111(C)	Fundamentals of Electric Circuits and Fields I	4-4
Ph-240(C)	Optics and Radiation from Atomic Systems	3-3
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-121(C)	Introduction to Engineering Mathematics	3-1
		13-9

SECOND TERM

Ma-122(B)	Differential Equations and Vector Calculus	5-0
Es-112(C)	Introduction to Circuit Theory II	4-3
Es-212(C)	Electron Tubes and Circuits I	4-3
Ph-620(B)	Atomic Physics	3-0
		16-6

THIRD TERM

Es-113(C)	Circuit Analysis and Measurements I	3-3
Es-213(C)	Electron Tube Circuits II	4-3
Ma-123(A)	Orthogonal Functions and Partial Differential Equations	5-0
Ph-730(A)	Physics of the Solid State	3-3
LP-101(L)	NPS Lecture Program I	0-1
		15-10

FOURTH TERM

Es-615(C)	Introduction to Electromagnetics	4-0
Es-114(C)	Circuit Analysis and Measurement II	3-3
Es-214(C)	Electron Tubes and Circuits III	4-3
Es-116(C)	Transient Circuit Theory	4-2
LP-102(L)	NPS Lecture Program II	0-1
		15-9

Intersessional period: Course IE-101(C) Elements of Management and Industrial Engineering at USNPS, at USNPS, Monterey.

SECOND YEAR (E2)

FIRST TERM

Es-124(C) Radio Frequency Measurements	2-3
Es-222(B) Transistor Electronics	3-3
Es-626(C) Guided Waves and Resonators	2-0
EE-463(C) Control Circuits	3-2
Es-326(C) Transmitters and Receivers	3-3
Es-821(C) Systems Lectures I	0-1
	13-12

SECOND TERM

Es-727(B) Antennas and Feed Systems	3-3
EE-672(A) Servomechanisms	3-3
Es-227(B) Ultra-high-frequency Techniques	3-2
Es-123(B) Pulse Techniques	3-3
Es-822(C) Systems Lectures II	0-1
	12-12

THIRD TERM

Es-129(B) Communication Theory	4-0
Es-422(B) Radar Systems I	3-3
Es-125(B) Electronic Computers	3-3
Es-327(B) Electronic Systems	3-3
Ph-427(B) Fundamental Acoustics	3-0
LP-101(L) NPS Lecture Program I	0-1
	16-10

FOURTH TERM

Es-423(B) Radar Systems II	3-6
Es-323(B) Missile Guidance Systems	3-0
Ph-428(B) Underwater Acoustics and Sonar Systems	3-3
Es-823(B) Systems Seminar	3-0
LP-102(L) NPS Lecture Program II	0-1
	12-10

THREE-YEAR CURRICULUM (SYSTEMS DESIGN)

(GROUP DESIGNATOR EA)

OBJECTIVE

To further the aims of the basic objective with further study in the basic sciences and special emphasis on systems design.

FIRST YEAR (EA1)

The first, second and third terms are the same as those given to the two-year curriculum (General).

FOURTH TERM

Es-114(C) Circuit Analysis and Measurements II	3-3
Es-214(C) Electron Tubes and Circuits III	4-3
Ma-124(B) Complex Variables	3-0
Ma-125(B) Numerical Methods for Digital Computers	2-2
Ph-113(A) Dynamics	4-0
LP-102(L) NPS Lecture Program II	0-1
	16-9

SECOND YEAR (EA2)

FIRST TERM

Ph-431(B) Fundamental Acoustics	4-0
Es-621(C) Electromagnetics I	4-0
Es-225(A) Electron Tubes	3-3
Es-126(C) R.F. Measurements and Microwave Techniques	2-6
	13-9

SECOND TERM

Ma-321(B) Probability and Statistics	4-2
Es-622(B) Electromagnetics II	5-0
Es-221(A) Transistor Electronics	3-3
Es-121(B) Advanced Circuit Theory I	4-2
	16-7

SECOND YEAR (EA2) (Continued)

THIRD TERM

Ph-432(B)	Underwater Acoustics and Sonar Systems	4-3
Es-127(B)	Pulse Forming Circuits	2-3
Es-623(A)	Electromagnetics III	4-0
Es-122(A)	Advanced Circuit Theory II	4-2
LP-101(L)	NPS Lecture Program I	0-1
		14-9

FOURTH TERM

Es-321(B)	Communications Systems I	3-3
Es-226(A)	Microwave Techniques	3-3
Es-726(B)	Antennas, Transmission Lines	3-3
Es-128(A)	Information Theory	4-0
LP-102(L)	NPS Lecture Program II	0-1
		13-10

During the intersessional period visits will be made to various naval and civilian industrial installations.

THIRD YEAR (EA2)

FIRST TERM

Es-431(B)	Radar Systems Engineering I	3-3
Es-136(A)	Introduction to Computers	3-2
EE-463(C)	Transformers, Controls, Motors and Special Machines	3-2
Oa-121(C)	Survey of Operations Analysis	3-0
Es-332(B)	Communication Systems II	2-3
		14-10

SECOND TERM

Es-432(B)	Radar Systems Engineering II	3-6
EE-672(A)	Servomechanisms	3-3
	Thesis	0-2
Es-333(B)	Communication Systems III	3-3
		9-14

THIRD TERM

This term is spent in an industrial electronics laboratory. During this period the student works as a junior engineer on a selected project which may form part of or be related to his thesis.

FOURTH TERM

Es-836(A)	Project Seminar	0-2
Me-246(B)	Nuclear Power Plants	3-0
	Thesis	4-0
Es-334(B)	Communication Systems IV	2-3
Es-335(B)	Electronic Systems	3-3
		12-8

THREE-YEAR CURRICULUM (ACOUSTICS)

(GROUP DESIGNATOR EW)

OBJECTIVE

To further the aims of the basic objective with special emphasis on underwater acoustics and sonar.

First Year and Second Year are same as Systems Design Curriculum.

THIRD YEAR (EW3)

FIRST TERM

Es-431(B)	Radar System Engineering I	3-3
EE-463(C)	Transformers, Controls, Motors and Special Machines	3-2
Oa-121(C)	Survey of Operations Analysis	3-0
Ph-461(A)	Transducer Theory and Design	3-3
Oc-110(C)	Introduction to Oceanography	3-0
		15-8

SECOND TERM

Es-432(B)	Radar System Engineering II	3-6
Es-537(B)	Sonar System Engineering Design and Developments	3-3
EE-672(A)	Servomechanisms	3-3
	Thesis	0-2
		9-14

THIRD TERM

This term is spent in an industrial electronics laboratory. During this period the student works as a junior engineer on a selected project which may form part of or be related to his thesis.

FOURTH TERM

Es-836(A)	Project Seminar	0-2
Me-246(B)	Nuclear Power Plants	3-0
Ph-433(A)	Propagation of Waves in Fluids	2-0
Ph-442(A)	Shock Waves in Fluids	3-0
Ph-471(A)	Acoustics Research	0-3
	Thesis	4-0
		12-5

ENGINEERING MATERIALS CURRICULUM

(GROUP DESIGNATOR NM)

OBJECTIVE

To educate officers in the engineering sciences and the principles involved in the treatment, properties, applications, and limitations of various engineering materials.

FIRST YEAR (NM1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
		14-10

SECOND TERM

EE-251(C)	Alternating-Current Circuits	3-4
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
Mc-102(C)	Engineering Mechanics II	2-2
		13-8

THIRD TERM

EE-351(C)	Direct Current Machinery	2-2
Mt-208(C)	Physical and Production Metallurgy	4-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Ch-221(C)	Qualitative Analysis	3-2
CE-521(A)	Plastics	3-2
		15-8

FOURTH TERM

EE-453(C)	Alternating-Current Mach.	3-4
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Ch-231(C)	Quantitative Analysis	2-4
ME-511(C)	Strength of Materials	5-0
		13-8

Intersessional period: IE-101(C) Elements of Management and Industrial Engineering will be taken at USNPS, Monterey.

SECOND YEAR (NM2)

FIRST TERM

CE-701(C)	Chemical Engineering Calculations	3-2
Ch-311(C)	Organic Chemistry	3-2
Cr-311(B)	Crystallography and Mineralogy	3-2
ME-522(B)	Strength of Materials	4-0
ME-611(C)	Mechanical Properties of Engineering Materials	2-2
		15-8

SECOND TERM

Ph-240(C)	Optics and Radiation from Atomic Systems	3-3
Ch-312(C)	Organic Chemistry	3-2
Mt-301(A)	High Temperature Materials	3-0
ME-622(B)	Experimental Stress Analysis	2-2
CE-611(C)	Thermodynamics	3-2
		14-9

THIRD TERM

Ch-411(C)	Physical Chemistry	3-2
CE-721(B)	Unit Operations	3-2
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
		11-6

FOURTH TERM

Ch-412(C)	Physical Chemistry	3-2
Ch-323(A)	The Chemistry of High Polymers	3-0
CE-112(A)	Fuels, Combustion, and High Energy Fuels	3-2
ME-246(B)	Nuclear Power Plants	3-0
		12-4

Intersessional period: A field trip will be arranged in industry during this period.

THIRD YEAR (NM3)

FIRST TERM

CE-722(A) Unit Operations	3-2
Mt-302(A) Alloy Steels	3-3
Mt-204(A) Non-Ferrous Metallography	3-3
Mt-305(B) Corrosion, Corrosion Protection	3-0
	12-8

SECOND TERM

Mt-306(B) Engineering Measurements	3-3
Mt-402(B) Nuclear Reactor Materials—Effects of Radiation	3-0
Mt-205(A) Adv Physical Metallurgy	3-4
Oc-140(C) General Oceanography and Marine Biology	3-0
Thesis	0-3
	12-10

THIRD TERM

Ch-582(A) Toxicology	3-0
CE-553(A) Nuclear Chemical Technology	4-3
Mt-800(A) Metallurgy Seminar	3-0
Thesis	0-10
	10-13

FOURTH TERM

Ch-800(A) Chemistry Seminar	3-0
Ma-301(B) Statistics	3-2
Mt-206(A) Adv Physical Metallurgy	3-4
Thesis	0-6
	9-12

This curriculum affords the opportunity to qualify for the degree, Master of Science.

GAS TURBINES

(GROUP DESIGNATOR NJ)

OBJECTIVE

To prepare officers in advanced mechanical engineering, with special emphasis on gas turbine application and development, for technical and administrative duties connected with naval machinery and engineering plants.

The students for the gas turbines program are normally selected, after the end of the first term, from the mechanical engineering (NH) group.

This comprises substantially the same program as mechanical engineering except that selected courses are directed toward gas turbine design and control problems, and thesis work is done in the gas turbine field.

(FIRST YEAR (NJ1)

FIRST TERM

Ch-121(B) General and Petroleum Chemistry	4-2
EE-171(C) Electrical Circuits and Fields	3-4
Ma-100(C) Vector Algebra and Geometry	2-1
Ma-111(C) Introduction to Engineering Mathematics	3-1
Mc-101(C) Engineering Mechanics I	2-2
	14-10

SECOND TERM

Ae-100(C) Basic Aerodynamics	3-4
EE-251(C) Alternating-Current Circuits	3-4
Ma-112 (B) Differential Equations and Infinite Series	5-0
Mc-102(C) Engineering Mechanics II	2-2
	13-10

THIRD TERM

EE-351(C) Direct-Current Machinery	2-2
Ae-121(C) Technical Aerodynamics	3-2
Ch-561(A) Physical Chemistry	3-2
Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-201(A) Methods in Dynamics	2-2
LP-101(L) NPS Lecture Program I	0-1
	13-9

FOURTH TERM

EE-453(C) Alternating Current Machinery	3-4
Ma-114(A) Functions of a Complex Variable and Vector Analysis	3-0
ME-111(C) Engineering Thermodynamics	4-2
ME-511(C) Strength of Materials	5-0
LP-102(L) NPS Lecture Program II	0-1
	15-7

Intersessional period: Course IE-101, Elements of Management and Industrial Engineering, will be taken at USNPS, Monterey.

SECOND YEAR (NJ2)

FIRST TERM

Ae-501(A) Hydro-Aero Mechanics I	4-0
Ma-115(A) Differential Equations for Automatic Control	3-0
ME-112(B) Engineering Thermodynamics	4-2
ME-512(A) Strength of Materials	5-0
ME-611(C) Mechanical Properties of Engineering Materials	2-2
	18-4

SECOND TERM

Ae-502(A) Hydro-Aero Mechanics II	4-0
EE-711(C) Electronics	3-2
ME-211(C) Marine Power Plant Equipment	3-2
ME-711(B) Mechanics of Machinery	4-2
Mt-201(C) Introductory Physical Metallurgy	3-2
	17-8

THIRD TERM

Ae-508(A) Compressibility	3-2
LP-101(L) NPS Lecture Program I	0-1
ME-212(C) Marine Power Plant Equipment	3-4
ME-513(A) Theory of Elasticity	3-0
ME-712(A) Dynamics of Machinery	3-2
Ma-125(B) Numerical Methods for Digital Computers	2-2
	14-11

FOURTH TERM

Ae-431(A) Aerothermodynamics of Turbomachines	4-1
Mt-208(C) Physical and Production Metallurgy	4-2
LP-102(L) NPS Lecture Program II	0-1
Ma-421(A) Digital and Analog Computation	3-2
ME-310(B) Heat Transfer	4-2
	15-8

Intersessional period: A field trip will be arranged in the gas turbine manufacturing industry.

THIRD YEAR (NJ3)

FIRST TERM

Ae-451(A)	Gas Turbines I	3-0
EE-651(B)	Transients and Servomechanisms	3-4
ME-612(A)	Experimental Stress Analysis	3-2
ME-811(C)	Machine Design	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	3-2
		15-10

SECOND TERM

Ae-452(A)	Gas Turbines II	3-0
CE-521(A)	Plastics	3-2
ME-812(B)	Machine Design	3-4
Mt-301(A)	High Temperature Materials	3-0
	Thesis	0-4
		12-10

THIRD TERM

LP-101(L)	NPS Lecture Program I	0-1
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
	Thesis	0-16
		3-17

FOURTH TERM

LP-102(L)	NPS Lecture Program II	0-1
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
Mt-302(A)	Alloy Steels	3-3
	Thesis	0-6
		9-14

This curriculum affords the opportunity to qualify for the degree of Master of Science in Mechanical Engineering.

MECHANICAL ENGINEERING

(GROUP DESIGNATOR NH)

OBJECTIVE

To prepare officers in advanced mechanical engineering, for technical and administrative duties ashore and afloat, involving research, development, design, and inspection of naval machinery and engineering plants.

BASIC CURRICULUM (TWO YEARS)

Designed to supply broad coverage in a variety of subjects which are essential to an understanding of modern naval engineering.

FIRST YEAR (NH1)

FIRST TERM

Ch-121(B) General and Petroleum Chemistry	4-2
EE-171(C) Electrical Circuits and Fields	3-4
Ma-100(C) Vector Algebra and Geometry	2-1
Ma-111(C) Introduction to Engineering Mathematics	3-1
Mc-101(C) Engineering Mechanics I	2-2
	14-10

SECOND TERM

EE-251(C) Alternating-Current Circuits	3-4
Ma-112(B) Differential Equations and Infinite Series	5-0
Mc-102(C) Engineering Mechanics II	2-2
Mt-201(C) Introductory Physical Metallurgy	3-2
	13-8

THIRD TERM

Ch-561(A) Physical Chemistry	3-2
EE-351(C) Direct-Current Machinery	2-2
Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-201(A) Methods in Dynamics	2-2
Mt-208(C) Physical and Production Metallurgy	4-2
LP-101(L) NPS Lecture Program I	0-1
	14-9

FOURTH TERM

EE-453(C) Alternating-Current Machinery	3-4
Ma-114(A) Functions of a Complex Variable and Vector Analysis	3-0
ME-111(C) Engineering Thermodynamics	4-2
ME-511(C) Strength of Materials	5-0
LP-102(L) NPS Lecture Program II	0-1
	15-7

Intersessional period. Course IE-101(C) Elements of Industrial Engineering, will be taken at USNPS, Monterey.

SECOND YEAR (NH2)

FIRST TERM

ME-122(C) Engineering Thermodynamics	3-2
ME-421(C) Hydromechanics	3-2
ME-522(B) Strength of Materials	4-0
ME-611(C) Mechanical Properties of Engineering Materials	2-2
Mt-203(C) Physical Metallurgy (Special Topics)	2-2
	14-8

SECOND TERM

ME-221(C) Marine Power Plant Equipment	3-2
ME-422(B) Hydromechanics	2-2
ME-622(B) Experimental Stress Analysis	2-2
ME-711(B) Mechanics of Machinery	4-2
Mt-301(A) High Temperature Materials	3-0
	14-8

THIRD TERM

EE-751(C) Electronics	3-4
LP-101(L) NPS Lecture Program I	0-1
ME-222(C) Marine Power Plant Equipment	3-4
ME-712(A) Dynamics of Machinery	3-2
Ph-610(B) Survey of Atomic and Nuclear Physics	3-0
	12-11

FOURTH TERM

CE-521(A) Plastics	3-2
LP-102(L) NPS Lecture Program II	0-1
ME-223(B) Marine Power Plant Analysis	2-4
ME-240(B) Nuclear Power Plants	4-0
ME-820(C) Machine Design	2-4
	11-11

This curriculum affords the opportunity to qualify for the degree of Bachelor of Science in Mechanical Engineering.

ADVANCED CURRICULUM (THREE YEARS)

Designed for students, chosen from the NH Group at the end of the first year, whose performance and records qualify them for advanced study.

FIRST YEAR

Same as first year (NH1)

Intersessional period: Course IE-101(C)—Elements of Management and Industrial Engineering at USNPS, Monterey.

SECOND YEAR (NHA2)

FIRST TERM

Ma-115(A) Differential Equations for Automatic Control	3-0
ME-112(B) Engineering Thermodynamics	4-2
ME-512(A) Strength of Materials	5-0
ME-611(C) Mechanical Properties of Engineering Materials	2-2
Mt-203(B) Physical Metallurgy (Special Topics)	2-2
	16-6

SECOND TERM

EE-711(C) Electronics	3-2
ME-211(C) Marine Power Plant Equipment	3-2
ME-411(C) Hydromechanics	3-2
ME-711(B) Mechanics of Machinery	4-2
	13-8

THIRD TERM

ME-212(C) Marine Power Plant Equipment	3-4
ME-412(A) Hydromechanics	4-2
Ma-125(B) Numerical Methods for Digital Computers	2-2
ME-712(A) Dynamics of Machinery	3-2
LP-101(L) NPS Lecture Program I	0-1
	12-11

FOURTH TERM

Ma-421(A) Digital and Analog Computation	3-2
ME-310(B) Heat Transfer	4-2
Mt-204(A) Non-Ferrous Metallography	3-3
ME-513(A) Theory of Elasticity	3-0
LP-102(L) NPS Lecture Program II	0-1
	13-8

Intersessional period: A four- or five-week field trip will be arranged to industrial or research activities.

THIRD YEAR (NHA3)

FIRST TERM

EE-651(B) Transients and Servomechanisms	3-4
ME-215(A) Marine Power Plant Analysis and Design	2-4
ME-612(A) Experimental Stress Analysis	3-2
ME-811(C) Machine Design	3-2
	11-12

SECOND TERM

ME-216(A) Marine Power Plant Analysis and Design	2-4
ME-812(B) Machine Design	3-4
Mt-301(A) High Temperature Materials	3-0
Thesis	0-2
	8-10

THIRD TERM

Ph-610(B) Survey of Atomic and Nuclear Physics	3-0
LP-101(L) NPS Lecture Program I	0-1
Thesis	0-16
	3-17

FOURTH TERM

CE-521(A) Plastics	3-2
ME-240(B) Nuclear Power Plants	4-0
Mt-302(A) Alloy Steels	3-3
LP-102(L) NPS Lecture Program II	0-1
Thesis	0-6
	10-12

This curriculum affords the opportunity to qualify for the degree of Master of Science in Mechanical Engineering.

NUCLEAR POWER CURRICULUM

NUCLEAR POWER

GROUP DESIGNATOR (NN)

OBJECTIVE

To educate officers in Reactor Engineering in order to prepare them for technical and administratve duties ashore and afloat involving the development and application of nuclear power.

FIRST YEAR (NN1)

FIRST TERM

Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Ch-121(B)	General and Petroleum Chemistry	4-2
Mc-101(C)	Engineering Mechanics	2-2
EE-171(C)	Electrical Circuits and Fields	3-4
		14-10

SECOND TERM

Ma-112(B)	Differential Equations and Infinite Series	5-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
EE-251(C)	Alternating-Current Fields	3-4
Mc-102(C)	Engineering Mechanics II	2-2
		13-8

THIRD TERM

Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Ch-561(A)	Physical Chemistry	3-2
Mt-208(C)	Physical and Production Metallurgy	4-2
Ph-660(B)	Atomic Physics	4-0
Ph-661(B)	Atomic Physics Laboratory	0-3
		14-7

FOURTH TERM

MA-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Ph-642(B)	Nuclear Physics	4-0
Ph-643(B)	Nuclear Physics Laboratory	0-3
ME-111(C)	Engineering Thermodynamics	4-2
ME-511(C)	Strength of Materials	5-0
		16-5

Intersessional period: Field trip to industral or research activities associated with the development of nuclear power.

SECOND YEAR (NN2)

FIRST TERM

ME-421(C)	Hydromechanics	3-2
ME-112(C)	Engineering Thermodynamics	4-2
ME-512(A)	Strength of Materials	5-0
ME-611(C)	Mechanical Properties of Engineering Materials	2-2
Mt-301(A)	High Temperature Materials	3-0
		17-6

SECOND TERM

Ch-552(A)	Radiochemistry	3-4
ME-422(B)	Hydromechanics	2-2
ME-210(C)	Marine Power Plant Equipment	3-2
ME-320(B)	Heat Transfer	3-2
Ph-651(A)	Reactor Theory	3-0
		14-10

THIRD TERM

ME-241(A)	Nuclear Power Plants	3-2
ME-710(B)	Mechanics of Machinery	4-2
Mt-402(B)	Nuclear Reactor Materials, Effects of Radiation	4-0
Ch-553(A)	Nuclear Chemical Technology	4-3
		15-7

FOURTH TERM

ME-242(A)	Nuclear Power Plants	3-2
ME-250(A)	Nuclear Reactor Laboratory	0-4
ME-223(B)	Marine Power Plant Analysis	3-2
ME-820(C)	Machine Design	2-4
Ph-810(C)	Biological Effects of Radiation	3-0
		11-12

This curriculum affords the opportunity to qualify for the degree, Bachelor of Science in Mechanical Engineering.

MINE WARFARE CURRICULUM

(GROUP DESIGNATOR RW)

OBJECTIVE

To educate officers in the various phases of mine warfare in order that they may have a thorough knowledge of mines and mine countermeasures; assist in the development of mines and mine countermeasures, advise commanders afloat in matters concerning mining and mine countermeasures, and analyze and formulate preliminary sweeping instructions for new types of mines discovered in the operating area.

FIRST YEAR (RW)

FIRST TERM

EE-151(C)	Direct-Current Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential equations	5-0
Ma-152(B)	Infinite Series	3-0
Or-193(C)	Mines and Mining Operations	2-2
		16-7

SECOND TERM

Ae-102(C)	Aerodynamics (Ord) I	3-0
Ae-103(C)	Aerodynamics (Ord) Lab I	0-2
EE-251(C)	Alternating-current Circuits	3-4
Ma-153(B)	Vector Analysis	3-0
Mc-101(C)	Engineering Mechanics I	2-2
Or-291(C)	Mine Countermeasures I	3-0
		14-8

THIRD TERM

Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-156(B)	Partial Differential Equations	3-0
Ma-391(C)	Basic Probability	4-2
Mc-102(C)	Engineering Mechanics II	2-2
Or-292(C)	Mine Countermeasures II	3-2
		15-4

FOURTH TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Es-262(C)	Electron Tubes and Circuits II	3-2
Ma-392(B)	Basic Statistics	5-2
Oa-152(C)	Measures of Effectiveness of Mines	3-0
Ph-161(A)	Hydrodynamics	3-0
		17-6

Intersessional period: Extended field trip to appropriate Bureau of Ships and Bureau of Ordnance activities providing a survey of current research and development in the mine warfare field.

SECOND YEAR (RW2)

FIRST TERM

Ch-401(A)	Physical Chemistry	3-2
EE-673(A)	Magnetic Amplifiers	2-3
Ma-116(A)	Matrices and Numerical Methods	3-2
Oc-110(C)	Introduction to Oceanography	3-0
Ph-421(A)	Fundamental Acoustics	3-0
		14-7

SECOND TERM

Ch-580(A)	Electrochemistry	3-2
Ma-421(A)	Digital and Analog Computation	3-2
Oa-153(B)	Game Theory and its Application to Mine Fields	3-0
Oc-631(A)	Oceanography of Mine Warfare I	3-0
Ph-425(A)	Underwater Acoustics	3-2
		15-6

THIRD TERM

Mt-201(C)	Introductory Physical Metallurgy	3-2
Oc-632(A)	Oceanography of Mine Warfare II	3-0
Ph-311(B)	Electrostaticstics and Magnetostatics	3-0
Ph-442(A)	Shock Waves in Fluids	3-0
	Thesis	0-10
		12-12

FOURTH TERM

CE-521(A)	Plastics	3-2
CE-591(A)	Blast and Shock Effects	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ph-312(A)	Applied Electromagnetics	3-0
Or-294(A)	Mine Warfare Seminar	2-0
	Thesis	0-7
		14-11

This curriculum is expected to afford an opportunity to qualify for the degree of Master of Science.

NUCLEAR ENGINEERING (EFFECTS)

(GROUP DESIGNATOR RZ)

OBJECTIVE

To educate officers in the fundamental sciences, particularly those associated with nuclear physics, in order that they may understand atomic processes and the effects of atomic weapons.

This curriculum has been established as a joint curriculum for selected officers of the Army, Navy, Air Force, Marine Corps and Coast Guard.

FIRST YEAR (RZ1)

FIRST TERM

Es-271(C) Electronics I	3-2
Ma-100(C) Vector Algebra and Geometry	2-1
Ma-181(C) Partial Derivatives and Multiple Integrals	4-1
Mc-101(C) Engineering Mechanics I	2-2
Ph-240(C) Geometrical and Physical Optics	3-3
	14-9

SECOND TERM

Ch-102(C) General Inorganic Chemistry	4-2
Es-272(C) Electronics II	3-3
Ma-182(C) Vector Analysis and Differential Equations	5-0
Ph-141(B) Analytical Mechanics	4-0
	16-5

THIRD TERM

Ch-414(C) Physical Chemistry	3-2
Es-273(C) Electronics III	3-2
Ma-183(B) Fourier Series and Complex Variables	5-0
ME-500(C) Strength of Materials	3-0
Ph-142(B) Analytical Mechanics	4-0
LP-101(L) NPS Lecture Program I	0-1
	18-5

FOURTH TERM

Ch-415(C) Physical Chemistry	3-2
Ma-184(A) Matrices and Numerical Methods	3-0
Mc-311(A) Vibrations	3-2
Ph-361(A) Electromagnetism	3-0
Ph-640(B) Atomic Physics	3-0
Ph-641(B) Atomic Physics Laboratory	0-3
LP-102(L) NPS Lecture Program II	0-1
	15-8

Intersessional period: Field trip.

SECOND YEAR (RZ2)

FIRST TERM

Ch-315(C) Organic Chemistry	3-2
Ma-301(B) Statistics	3-2
Mr-100(C) Fundamentals of Atmospheric Circulation	2-0
Ph-362(A) Electromagnetic Waves	3-0
Ph-530(B) Thermodynamics	3-0
Ph-720(A) Introductory Quantum Mechanics	3-0
Ph-750(A) Physics Seminar	1-0
	18-4

SECOND TERM

Ph-800(C) General Biology	6-0
Ph-441(A) Shock Waves in Fluids	4-0
Ph-541(B) Kinetic Theory and Statistical Mechanics	4-0
Ph-642(B) Nuclear Physics	4-0
Ph-643(B) Nuclear Physics Laboratory	0-3
Ph-750(A) Physics Seminar	1-0
	19-3

THIRD TERM

Ph-801(B) Animal Physiology	6-0
Ch-551(A) Radiochemistry	2-2
CE-591(A) Blast and Shock Effects	3-0
ME-550(B) Elements of Dynamic Structural Analysis	5-0
LP-101(L) NPS Lecture Program I	0-1
Ph-750(A) Physics Seminar	1-0
Thesis	0-6
	17-9

FOURTH TERM

Ph-802(A) Radiation Biology	6-0
Ge-201(C) Physical Geology	3-0
ME-350(B) Heat Transfer	2-2
LP-102(L) NPS Lecture Program II	0-1
Ph-750(A) Physics Seminar	1-0
Thesis	0-10
	12-13

This curriculum affords an opportunity to qualify for the degree of Master of Science in Physics.

OPERATIONS ANALYSIS

(GROUP DESIGNATOR RO)

OBJECTIVE

To develop the analytical ability of officers by providing a sound scientific background and extensive education in scientific and analytical methods so that they may formulate new work in operations analysis, apply the results of operations research studies with greater effectiveness, and solve the simpler problems in operations analysis which arise both in the fleet and ashore.

FIRST YEAR (RO1)

FIRST TERM

Ma-120(C) Vector Algebra and Geometry	3-1
Ma-181(C) Partial Derivatives and Multiple Integrals	4-1
Ma-391(C) Basic Probability	4-2
Ph-341(C) Electricity and Magnetism	4-2
	15-6

SECOND TERM

Ma-182(C) Vector Analysis and Differential Equations	5-0
Ma-392(B) Basic Statistics	5-2
Oa-191(C) Introduction to Operations Analysis	4-0
Ph-321(B) Electromagnetism I	3-0
	17-2

THIRD TERM

Ma-116(A) Matrices and Numerical Methods	3-2
Ma-183(B) Fourier Series and Complex Variables	5-0
Ma-501(A) Theory of Games	2-2
Mc-191(B) Mechanics I	4-0
Ph-322(B) Electromagnetism II	3-0
	17-4

FOURTH TERM

Ma-195(A) Matrix Theory and Integration Theory	3-0
Ma-385(A) Statistical Decision Theory	3-0
Ma-421(A) Digital and Analog Computation	3-2
Mc-192(B) Mechanics II	4-0
Ph-241(B) Radiation	3-3
	16-5

Intersessional period: The student is assigned for approximately nine weeks as a working member of a civilian or military Operations Research Group engaged in military problems.

SECOND YEAR (RO2)

FIRST TERM

Oa-192(B) Search Theory and Air Defense	4-0
Oa-201(A) Logistics Analysis	5-2
Oa-203(A) Personnel Analysis	3-0
Ph-640(B) Atomic Physics	3-0
Ph-641(B) Atomic Physics Lab	0-3
	15-5

SECOND TERM

Oa-193(B) Weapons Systems	4-0
Oa-891(A) Seminar in Operations Analysis	2-2
Ph-451(B) Underwater Acoustics	4-2
Ph-642(A) Nuclear Physics	4-0
Ph-643(A) Nuclear Physics Lab	0-3
	14-7

NOTE: The content and duration of this curriculum are tentative subject to further review and final approval by the Chief of Naval Personnel.

ORDNANCE ENGINEERING (GENERAL)

(GROUP DESIGNATOR O)

OBJECTIVE

To further the aims of the basic objective by providing officer students with the fundamental mathematics and basic sciences essential to their development in the field of Ordnance Engineering. Major emphasis is placed on automatic control theory with its supporting mathematics, as being most generally applicable in the field of Naval Ordnance, and a foundation is provided for the officers' development with experience in associated engineering and scientific fields.

FIRST YEAR (O)

FIRST TERM

EE-151(C) Direct-current Circuits and Fields	3-4
Ma-120(C) Vector Algebra and Geometry	3-1
Ma-151(C) Differential Equations	5-0
Ma-152(B) Infinite Series	3-0
	14-5

SECOND TERM

Ch-101(C) General Inorganic Chemistry	3-2
EE-251(C) Alternating Current Circuits	3-4
Ma-124(B) Complex Variable	3-0
Ma-153(B) Vector Analysis	3-0
Mc-101(C) Engineering Mechanics I	2-2
	14-8

THIRD TERM

EE-463(C) Special Machinery	3-2
Es-261(C) Electron Tubes and Circuits I	3-2
Ma-155(A) Differential Equations for Automatic Control	3-0
Mc-102(C) Engineering Mechanics II	2-2
Mt-201(C) Introductory Physical Metallurgy	3-2
Or-241(C) Guided Missiles I	2-0
	16-8

FOURTH TERM

EE-671(A) Transients	3-4
Es-262(C) Electron Tubes and Circuits II	3-2
Mc-201(A) Methods in Dynamics	2-2
Mc-202(C) Ferrous Physical Metallurgy	3-2
Or-242(B) Guided Missiles II	2-0
	13-10

Intersessional period: Field trip to representative ordnance installations.

SECOND YEAR (O2)

FIRST TERM

EE-672(A) Servomechanisms	3-3
EE-756(A) Electrical Measurements of Non-Electrical Quantities	3-3
Es-446(C) Introduction to Radar	2-2
Mc-402(A) Mechanics of Gyroscopic Instruments	3-0
ME-500(C) Strengths of Materials	3-0
ME-601(C) Materials Testing Lab	0-2
	14-10

SECOND TERM

Ch-401(A) Physical Chemistry	3-2
EE-674(A) Advanced Linear Servo Theory	3-0
Ma-116(A) Matrices and Numerical Methods	3-2
Mc-311(A) Vibrations	3-2
Ph-450(B) Underwater Acoustics	3-2
	15-8

THIRD TERM

EE-573(A) Non-Linear Servo Mechanisms	3-2
Ma-351(B) Industrial Statistics I	3-2
Ma-421(A) Digital and Analog Computation	3-2
Or-101(C) Ordnance I	2-1
Ph-240(C) Optics and Radiation from Atomic Systems	3-3
	14-10

FOURTH TERM

CE-541(A) Reaction Motors	2-2
Ch-571(A) Explosives	3-2
EE-675(A) Sampled Data Servo Systems	3-0
Ma-352(B) Industrial Statistics II	2-2
Oa-151(B) Survey of Weapons Evaluation	3-0
Ph-610(B) Survey of Atomic and Nuclear Physics	3-0
	16-6

This curriculum affords an opportunity to qualify for a Bachelor of Science degree in Electrical Engineering.

THE ENGINEERING SCHOOL

ORDNANCE ENGINEERING (Aviation)

(GROUP DESIGNATOR OE)

OBJECTIVE

To further the aims of the basic objective by emphasizing the aviation aspects of ordnance, including the limitations and peculiar advantages that are inherent in the aviation field.

FIRST YEAR (OE1)

FIRST TERM

Ch-101(C) General Inorganic Chemistry	3-2
EE-151(C) DC Circuits and Fields	3-4
Ma-100(C) Vector Algebra and Geometry	2-1
Ma-111(C) Introduction to Engineering Mathematics	3-1
Mc-101(C) Engineering Mechanics I	2-2
	13-10

SECOND TERM

Ae-100(C) Basic Aerodynamics	3-4
CE-711(C) Chemical Engineering Calculations	3-2
EE-241(C) AC Circuits	3-2
Ma-112(B) Differential Equations and Infinite Series	5-0
Mc-102(C) Engineering Mechanics II	2-2
Ae-001(L) Aeronautical Lecture	0-1
	16-11

THIRD TERM

Ae-121(C) Technical Aerodynamics	3-2
CE-631(A) Chemical Engineering Thermodynamics	3-2
EE-461(C) Transformers and Synchros	3-2
Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-401(A) Exterior Ballistics	3-0
	15-6

FOURTH TERM

Ae-136(B) Aircraft Performance—Flight Analysis	3-2
Ch-401(A) Physical Chemistry (Ordnance)	3-2
EE-462(B) Asynchronous Motors and Special Machines	4-2
Ma-114(A) Functions of a Complex Variable and Vector Analysis	3-0
Or-104(C) Ordnance IV	2-1
	15-7

Intersessional period: Field trip to representative ordnance installations.

SECOND YEAR (OE2)

FIRST TERM

Ae-501(A) Hydro-Aero Mechanics I	4-0
Ch-571(A) Explosives	3-2
EE-751(C) Electronics	3-4
Ma-115(A) Differential Equations for Automatic Control	3-0
Mt-201(C) Introductory Physical Metallurgy	3-2
	16-8

SECOND TERM

Ae-502(A) Hydro-Aero Mechanics II	4-0
EE-745(A) Electronic Control and Measurement	3-3
Ma-125(B) Numerical Methods for Digital Computers	2-2
Mc-402(A) Mechanics of Gyroscopic Instruments	3-0
Mt-202(C) Ferrous Physical Metallurgy	3-2
Or-101(C) Ordnance I	2-1
	17-8

THIRD TERM

Ae-146(A) Dynamics	3-2
Ae-508(A) Compressibility	3-2
EE-665(B) Lines, Filters, and Transients	4-2
Ma-421(A) Digital and Analog Computation	3-2
Or-241(C) Guided Missiles I	2-0
	15-8

FOURTH TERM

CE-541(A) Reactions Motors	2-2
EE-672(A) Servomechanisms	3-3
Es-456(C) Introduction to Radar (Airborne)	2-2
Ma-301(B) Statistics	3-2
Oa-151(B) Survey of Weapons Evaluation	3-0
Or-242(B) Guided Missiles II	2-0
	15-9

Intersessional period: IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

ORDNANCE ENGINEERING CURRICULA

THIRD YEAR (OE3)

At Massachusetts Institute of Technology

FALL SEMESTER

16.15 Advanced Stability and Control of Aircraft
16.39 Vector Kinematics and Gyroscopic Instrument Theory
16.41 Fire Control Principles
16.43 Fire Control Instrument Lab
16.472 Rockets, Guided Missiles and Projectiles

SPRING SEMESTER

16.40 Automatic Control Equipment for Aircraft
16.42 Fire Control Systems
16.44 Fire Control Instruments Laboratory (Advanced)
Thesis

This curriculum affords an opportunity to qualify for the degree of Master of Science. For groups entering after August 1956 this curriculum will be combined with Ordnance Engineering (Guided Missiles) curriculum.

ORDNANCE ENGINEERING (EXPLOSIVES AND PROPELLANTS)

(GROUP DESIGNATOR OP)

OBJECTIVE

To further the aims of the basic objective by providing officer students with an intensive course of study in the chemistry of explosives and propellants, along with a minimum coverage of the basic mathematics and related sciences most applicable to Ordnance Engineering billets in this field.

FIRST YEAR (OP)

FIRST TERM

EE-151(C) Direct-current Circuits and Fields	3-4
Ma-120(C) Vector Algebra and Geometry	3-1
Ma-151(C) Differential Equations	5-0
Ma-152(B) Infinite Series	3-0
	14-5

SECOND TERM

Ch-101(C) General Inorganic Chemistry	3-2
Ch-221(C) Qualitative Analysis	3-2
EE-251(C) Alternating-current Circuits	3-4
Ma-154(B) Operational Calculus	3-0
Or-104(C) Ordnance IV	2-1
	16-7

THIRD TERM

Ch-231(C) Quantitative Analysis	2-4
Ch-302(C) Organic Chemistry	4-2
CE-711(C) Chemical Engineering Calculations	3-2
EE-751(C) Electronics	3-4
	12-12

FOURTH TERM

CE-612(C) Fundamental Thermodynamics	3-2
Ch-443(C) Physical Chemistry	4-2
Ch-571(A) Explosives	3-2
EE-463(C) Special Machinery	3-4
	13-10

Intersessional period: Extended field trips to Ordnance activities or contractors working in the field of explosives or propellants.

SECOND YEAR (OP2)

FIRST TERM

CE-614(A) Thermodynamics	3-2
Ch-324(A) Organic Qualitative Analysis	2-4
Ch-444(A) Physical Chemistry, Adv	3-4
EE-671(A) Transients	3-4
	11-14

SECOND TERM

CE-624(A) Advanced Thermodynamics	3-2
Ch-416(A) Physical Chemistry, Adv	3-2
Ch-800(A) Chemistry Seminar (Expl)	0-2
EE-672(A) Servomechanisms	3-3
Mt-201(C) Introduction to Physical Metallurgy	3-2
	12-11

THIRD TERM

CE-521(A)	Plastics	3-2
CE-541(A)	Reaction Motors	2-2
Mt-202(C)	Ferrous Physical Metallurgy	3-2
	Thesis	0-8
		8-14

FOURTH TERM

CE-112(A)	High Energy Fuels	3-2
CE-591(A)	Blast and Shock Effects	3-0
CE-625(A)	High Temperature Thermodynamics	2-2
Ch-323(A)	The Chemistry of High Polymers	3-0
Mt-301(A)	High Temperature Materials	3-0
	Thesis	0-6
		14-10

This curriculum is expected to afford an opportunity to qualify for the degree of Master of Science in Chemistry.

ORDNANCE ENGINEERING (FIRE CONTROL)

(GROUP DESIGNATOR OF)

OBJECTIVE

To further the aims of the basic objective by providing officer students with the fundamental mathematics and applicable basic sciences, followed by intensive study in Fire Control theory, to insure the officers' grasp of this important facet of Naval Ordnance. Emphasis is maintained on the broadened concepts of control associated with new weapons systems.

FIRST YEAR (OF1)

FIRST TERM

EE-151(C)	Direct-current Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
		14-5

SECOND TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-251(C)	Alternating-Current Circuits	3-4
Ma-124(B)	Complex Variables	3-0
Ma-153(B)	Vector Analysis	3-0
Mc-101(C)	Engineering Mechanics	2-2
		14-8

THIRD TERM

EE-463(C)	Special Machinery	3-2
Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-155(A)	Differential Equations for Automatic Control	3-0
Mc-102(C)	Engineering Mechanics II	2-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
Or-241(C)	Guided Missiles I	2-0
		16-8

FOURTH TERM

EE-671(A)	Transients	3-4
Es-262(C)	Electron Tubes and Circuits II	3-2
Mc-201(A)	Methods in Dynamics	2-2
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Or-242(B)	Guided Missiles II	2-0
		13-10

Intersessional period: Field trip to representative ordnance installations.

SECOND YEAR OF2)

FIRST TERM

EE-672(A)	Servomechanisms	3-3
EE-756(A)	Electrical Measurement of Non-Electrical Quantities	3-3
Es-267(A)	Electron Tubes and Ultra-High Frequency Techniques	3-2
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
ME-500(C)	Strength of Materials	3-0
		15-8

SECOND TERM

EE-674(A)	Advanced Linear Servo Theory	3-0
Es-461(A)	Pulse Techniques	3-3
Ma-116(A)	Matrices and Numerical Methods	3-2
Mc-311(A)	Vibrations	3-2
Mc-403(A)	Kinematics of Guidance	3-0
		15-7

THIRD TERM

EE-673(A) Non-Linear Servomechanisms	3-2
Ma-352(B) Industrial Statistics II	2-2
Ma-421(A) Digital and Analog Computation	3-2
Oa-151(B) Survey of Weapons Evaluation	3-0
Ph-240(C) Optics and Radiation from Atomic Systems	3-3
	15-9

FOURTH TERM

Ch-401(A) Physical Chemistry	3-2
EE-675(A) Sampled Data Servo Systems	3-0
EE-676(A) Linear and Non-Linear Servo Compensation	3-0
Ma-352(B) Industrial Statistics II	2-2
Ma-401(A) Analog Computers	2-2
Ph-610(B) Survey of Atomic and Nuclear Physics	3-0
	16-6

Intersessional period: IE-102(C)—Elements of Management and Industrial Engineering at USNPS, Monterey.

THIRD YEAR (OF3)

At Massachusetts Institute of Technology

FALL TERM

16.33 Instrumentation and Control Lab.
16.39 Vector Kinematics & Gyroscopic Instrument Theory
16.41 Fire Control Principles
16.472 Rockets, Guided Missiles, and Projectiles
6.291 Principles of Radar
Thesis

SPRING TERM

16.42 Fire Control Systems
16.44 Advanced Fire Control Instruments Laboratory
*16.38 Control Systems Components
Thesis
* Professional Elective

This curriculum affords an opportunity to qualify for the degree of Master of Science.

ORDNANCE ENGINEERING (UNDERWATER ORDNANCE)

(GROUP DESIGNATOR OU)

OBJECTIVE

To further the aims of the basic objective by providing officer students with the basic sciences and engineering fundamentals essential to their professional development in and with the field of Underwater Ordnance. Major emphasis is placed on the control and guidance of mobile underwater weapons with a foundation provided for the comprehension of associated problems in this field.

FIRST YEAR (OU)

FIRST TERM

EE-151(C) Direct-current Circuit and Fields	3-4
Ma-120(C) Vector Algebra and Geometry	3-1
Ma-151(C) Differential Equations	5-0
Ma-152(B) Infinite Series	3-0
	14-5

SECOND TERM

Ae-102(C) Aerodynamics (Ord) I	3-0
Ae-103(C) Aerodynamics (Ord) Lab	0-2
EE-251(C) Alternating-Current Circuits	3-4
Ma-124(B) Complex Variable	3-0
Ma-153(B) Vector Analysis	3-0
Mc-101(C) Engineering Mechanics I	2-2
	14-8

THIRD TERM

EE-463(C) Special Machinery	3-2
Es-261(C) Electron Tubes and Circuits I	3-2
Ma-155(A) Differential Equations for Automatic Control	3-0
Ma-156(B) Partial Differential Equations	3-0
Mc-102(C) Engineering Mechanics	2-2
Or-105(C) Survey of Underwater Ord	1-2
	15-8

FOURTH TERM

Ch-101(C) General Inorganic Chemistry	3-2
EE-671(A) Transients	3-4
Es-262(C) Electron Tubes and Circuits II	3-2
Mc-201(A) Methods in Dynamics	2-2
Ph-161(A) Hydrodynamics	3-0
	14-10

Intersessional period: Extended field trips to appropriate ordnance activities providing a survey of current development work in the field of Underwater Ordnance.

SECOND YEAR (OU2)

FIRST TERM

Ch-401(A) Physical Chemistry	3-2
EE-672(A) Servomechanisms	3-3
EE-756(A) Electrical Measurement of Non-Electrical Quantities	3-3
Mc-401(A) Mechanics of Gyroscopic Instruments	3-0
Ph-431(B) Fundamental Acoustics	4-0
	16-8

SECOND TERM

Ch-580(A) Electrochemistry	3-2
EE-674(A) Advanced Linear Servo Theory	3-0
Mc-311(A) Vibrations	3-2
Mc-403(A) Kinematics of Guidance	3-0
Ph-432(A) Underwater Acoustics and Sonar Systems	4-3
	16-7

THIRD TERM

EE-673(A) Non-Linear Servomechanisms	3-2
Ma-116(A) Matrices and Numerical Methods	3-2
Ma-351(B) Industrial Statistics I	3-2
Ph-311(B) Electrostatics and Magnetostatics	3-0
Ph-442(A) Shock Waves in Fluids	3-0
	15-6

FOURTH TERM

EE-675(A) Sampled Data Servo Systems	3-0
Ma-352(B) Industrial Statistics II	2-2
Ma-421(A) Digital and Analog Computation	3-2
Ph-312(A) Applied Electromagnetics	3-0
Ph-461(A) Transducer Theory and Design	3-3
	14-7

ORDNANCE ENGINEERING (GUIDED MISSILES)

(GROUP DESIGNATOR OG)

OBJECTIVE

To further the aims of the basic objective by providing officer students with the essentials for their development in and with the field of guided missiles, both ashore and afloat. With major emphasis on preparation for guidance problems, a foundation is provided for comprehending the associated problems involving the aerodynamics, structures, war-heads, and propulsion of guided missiles.

FIRST YEAR (OG)

FIRST TERM

EE-151(C) Direct-current Circuits and Fields	3-4
Ma-120(C) Vector Algebra and Geomtery	3-1
Ma-151(C) Differential Equations	5-0
Ma-152(B) Infinite Series	3-0
	14-5

SECOND TERM

Ch-101(C) General Inorganic Chemistry	3-2
EE-251(C) Alternating Current Circuits	3-4
Ma-124(B) Complex Variables	3-0
Ma-153(B) Vector Analysis	3-0
Mc-101(C) Engineering Mechanics I	2-2
	14-8

THIRD TERM

Ae-102(C) Aerodynamics (Ord) I	3-0
Ae-103(C) Aerodynamics Laboratory I	0-2
EE-463(C) Special Machinery	3-2
Es-261(C) Electron Tubes and Circuits I	3-2
Ma-155(A) Differential Equations for Automatic Control	3-0
Mc-102(C) Engineering Mechanics II	2-2
	14-8

FOURTH TERM

Ae-122(C) Aerodynamics (Ord) II	3-0
Ae-123(C) Aerodynamics Laboratory II	0-2
EE-671(A) Transients	3-4
Es-262(C) Electron Tubes & Circuits II	3-2
Mc-201(A) Methods in Dynamics	2-2
Mr-101(C) Fundamentals of Atmospheric Circulation	2-0
	13-10

Intersessional period: Extended field trips to appropriate ordnance activities providing a survey of current development work in the field of Guided Missiles.

SECOND YEAR (OG2)

FIRST TERM

Ae-505(A) Compressible Flow (Ord) I	4-0
EE-672(A) Servomechanisms	3-3
EE-756(A) Electrical Measurements of Non-Electrical Quantities	3-3
Es-267(A) Electron Tubes and Ultra-High Frequency Techniques	3-2
Mc-402(A) Mechanics of Gyroscopic Instruments	3-0
	16-8

SECOND TERM

Ae-506(A) Compressible Flow (Ord) II	3-2
EE-674(A) Advanced Linear Servo Theory	3-0
Es-461(A) Pulse Techniques	3-3
Ma-116(A) Matrices and Numerical Methods	3-2
Mc-311(A) Vibrations	3-2
	15-9

THIRD TERM

Ae-143(B) Missile Dynamics	3-2
EE-673(A) Non-Linear Servo Mechanisms	3-2
Es-422(A) Radar Systems I	3-3
Ma-421(A) Digital and Analog Computation	3-2
Or-241(C) Guided Missiles I	2-0
	15-10

FOURTH TERM

EE-675(A) Sampled Data Servo Systems	3-0
Es-341(C) Radiotelemetry and Simulation	3-3
Es-423(B) Radar Systems II	3-6
Mc-403(A) Kinematics of Guidance	3-0
Or-242(B) Guided Missiles II	2-0
	14-9

ORDNANCE ENGINEERING (GUIDED MISSILES)

INTERSESSIONAL PERIOD—INDUSTRIAL EXPERIENCE TOUR

This period (9 weeks) is spent in a guided missiles laboratory working under the cognizance of or under contract to the Bureau of Ordnance. The officer student works as a junior engineer on a project related to or forming a part of his thesis.

THIRD YEAR (OG3)

FIRST TERM		SECOND TERM	
Ch-401(A) Physical Chemistry	3-2	CE-541(A) Reaction Motors	2-2
CE-631(A) Chemical Engineering Thermodynamics	3-0	Ma-352(B) Industrial Statistics II	2-2
EE-676(A) Linear and Non-Linear Servo Compensation	3-0	ME-310(A) Heat Transfer	4-2
Ma-351(B) Industrial Statistics I	3-2	Mt-201(C) Introductory Physical Metallurgy	3-2
Thesis	0-8	Thesis	0-4
	12-12		11-12

MID-YEAR GRADUATION

This curriculum is expected to afford the opportunity to qualify for the degree of Master of Science in Electrical Engineering.

ORDNANCE ENGINEERING (SPECIAL PHYSICS)

(GROUP DESIGNATOR OX)

OBJECTIVE

The objective of Ordnance Engineering (Special Physics) is to educate officers in the fundamentals of Nuclear Physics with particular emphasis on those topics basic to the field of nuclear and thermonuclear weapons in order to develop their capacity for understanding and evaluating the capabilities and limitations of these weapons.

FIRST YEAR (OX)

FIRST TERM

EE-151(C)	Direct-current Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
		14-5

SECOND TERM

EE-251(C)	Alternating-current Circuits	3-4
Ma-124(B)	Complex Varible	3-0
Ma-153(B)	Vector Analysis	3-0
Ph-141(B)	Analytical Mechanics	4-0
Ph-240(C)	Optics and Radiation from Atomic Systems	3-3
		16-7

THIRD TERM

EE-474(C)	Synchros	2-0
Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-155(A)	Differential Equations for Automatic Control	3-0
Ma-156(B)	Partial Differential Equations	3-0
Ph-142(B)	Analytical Mechanics	4-0
Ph-361(A)	Electromagnetism	3-0
		18-2

FOURTH TERM

EE-671(A)	Transients	3-4
Es-262(C)	Electron Tubes and Circuits II	3-2
Ph-144(A)	Analytical Mechanics	4-0
Ph-362(A)	Electromagnetic Waves	3-0
Ph-530(B)	Thermodynamics	3-0
		16-6

Intersessional period: Western field trip to activities concerned with nuclear weapons development, test, and defense including a specially tailored Weapons Employment Course by the Special Weapons Training Group of the Field Command, AFSWP.

SECOND YEAR (OX2)

FIRST TERM

EE-672(A)	Servomechanisms	3-3
Es-267(A)	Ultra-High Frequency Techniques	3-2
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Lab	0-3
Ph-750(A)	Physics Seminar	1-0
		14-8

SECOND TERM

Es-461(A)	Pulse Techniques	3-3
Ma-116(A)	Matrices and Numerical Methods	3-2
Ph-642(A)	Nuclear Physics	4-0
Ph-643(A)	Nuclear Physics Lab	0-3
Ph-721(A)	Introductory Quantum Mechanics	4-0
Ph-750(A)	Physics Seminar	1-0
		15-8

THIRD TERM

Es-161(A)	Electronic Instrumentation I	3-3
Ma-351(B)	Industrial Statistics I	3-2
Ma-421(A)	Digital and Analog Computers	3-2
Ph-644(A)	Advanced Nuclear Physics	4-0
Ph-645(A)	Advanced Nuclear Physics Lab	0-3
Ph-750(A)	Physics Seminar	1-0
		14-10

FOURTH TERM

EE-673(A)	Non-Linear Servomechanisms	3-2
Es-162(A)	Electronic Instrumentation II	3-3
Ma-352(B)	Industrial Statistics II	2-2
Ph-650(A)	Nuclear Instrumentation	4-0
Ph-723(A)	Physics of the Solid State	4-0
Ph-750(A)	Physics Seminar	1-0
		17-7

Intersessional period: Eastern Field trip to BuOrd and appropriate organizations in the Washington, D. C. area concerned with nuclear weapons and to a national laboratory engaged in nuclear research.

THE ENGINEERING SCHOOL

ORDNANCE ENGINEERING (SPECIAL PHYSICS)

THIRD YEAR (OX3)

The third year consists of approximately ten months work in a junior staff capacity at the Berkeley Radiation Laboratory of the University of California. A thesis is prepared during this period under the aegis of the Naval Postgraduate School. This curriculum affords the opportunity to qualify for the degree of Master of Science in Physics from the Naval Postgraduate School.

PETROLEUM ENGINEERING CURRICULUM

PETROLEUM LOGISTICS

(GROUP DESIGNATOR NS)

OBJECTIVE

To qualify officers of the Supply Corps for petroleum duties with operational staffs, terminals, and logistics agencies and to educate officers of the Civil Engineering Corps for duties involving petroleum matters. The curriculum consists of one year at the Naval Postgraduate School and one year in the field at the representative installations and facilities of a major oil industry.

FIRST YEAR (NS1)

FIRST TERM

Ma-111(C) Introduction to Engineering Mathematics	3-1
Ch-101(C) General Inorganic Chemistry	3-2
Cr-301(B) Crystallography and Mineralogy	3-4
Mc-101(C) Engineering Mechanics	2-2
	11-9

SECOND TERM

Ma-112(B) Differential Equations and Infinite Series	5-0
CE-111(A) Fuel and Oil Chemistry	2-2
Ge-101(C) Physical Geology	3-2
Mt-201(C) Introductory Physical Metallurgy	3-2
	13-6

THIRD TERM

Oa-201(A) Logistics Analysis	3-2
Ch-800(B) Petroleum Seminar	4-0
Ge-241(A) Geology of Petroleum	2-4
Ch-561(A) Physical Chemistry	3-2
	12-8

FOURTH TERM

Ch-800(B) Petroleum Seminar	4-0
Ge-242(A) Geology of Petroleum and Petroleum Reserves	2-4
Mt-202(C) Ferrous Physical Metallurgy	3-2
CE-731(A) Petroleum Refinery Engineering	3-0
	12-6

SECOND YEAR (NS2)

The second year of this curriculum will be spent in the field at various representative installations and facilities of a major oil industry.

CURRICULA CONDUCTED ENTIRELY AT OTHER INSTITUTIONS

The short titles and descriptive names of the courses are taken from the college catalogue concerned. Further information must be sought in such catalogue.

All of these curricula are subject to changes from year to year, due to scheduling problems at the institution, the backgrounds of individual students, and other reasons.

Each curriculum is assigned to one of the curricular officers of the Engineering School for supervision and administration of the Postgraduate School responsibilities, including initiation of changes to the curriculum, contact with students and college faculty, and related functions.

DESCRIPTIONS

CIVIL ENGINEERING (Qualification)

(GROUP DESIGNATOR ZGQ)

At Rensselaer Polytechnic Institute

OBJECTIVE

A seventeen-month curriculum, to qualify officers for civil engineering duties. Successful completion of this course normally leads to appointment in the Civil Engineer Corps. At present this is the only program for transfer of line officers to the Civil Engineer Corps.

Refresher Period 8 weeks

11.90 Mathematics (CEC)
17.05 Mechanics and Strength of Materials (CEC)
5.08 Surveying Curves and Earthwork (CEC)

SUMMER SESSION

5.76 Structural Analysis I
5.78 Reinforced Concrete I
10.11 Engineering Geology

FALL TERM

5.05 Photogrammetry (CEC)
5.09 Contracts and Specifications
5.15 Highways and Airports (CEC)
5.75 Building Construction
5.77 Structural Design I
5.80 Structural Analysis II
7.72 Utilization of Electrical Energy in Naval Establishment (CEC)

SPRING TERM

5.32 Soil Mechanics (CEC)
5.79 Reinforced Concrete II
T5.82 Indeterminate Structures I
12.42 Heating and Ventilation (CEC)
13.541 Metallurgy and Welding (CEC)
G5.82 Shipbuilding and Ship Repair Facilities (CEC)
T6.28 Cost Finding and Control

SECOND SUMMER SESSION

5.16 Topographical Survey (Field Trip)
5.18 Route Survey (Field Trip)
5.59 Sanitary Engineering
7.69 Power Plants (CEC) Electrical Engineering
12.48 Power Plants (CEC) Mechanical Engineering
5.35 Foundation Engineering (CEC)

This curriculum affords the opportunity to qualify for the degree of Bachelor of Civil Engineering.

CIVIL ENGINEERING (Advanced)
SOIL MECHANICS AND FOUNDATIONS

(GROUP DESIGNATOR ZGR)

At Rensselaer Polytechnic Institute

OBJECTIVE

To provide advanced technical education for selected CEC officers in the field of soil mechanics and foundations.

SUMMER TERM

11.25 Engineering Mathematics
10.11 Engineering Geology
Soil Mechanics and Foundations Refresher

FALL TERM

11.41 Advanced Calculus
10.12 Advanced Engineering Geology
G5.30 Soil Mechanics I
G5.32 Foundation Engineering I
G5.87 Prestressed Concrete
G5.37 Soil Mechanics III

SPRING TERM

G5.31 Soil Mechanics II
G5.33 Foundation Engineering II
T5.25 Hydrology
G5.82 Shipbuilding and Ship Repair Facilities (CEC)
G5.36 Soil Mechanics Seminar
G5.49 Thesis

This curriculum affords the opportunity to qualify for the degree of Master of Civil Engineering.

CIVIL ENGINEERING (Advanced)

STRUCTURES

(GROUP DESIGNATOR ZGI)

At the University of Illinois

OBJECTIVE

To provide advanced technical instruction for selected CEC officers in the field of structural design.

FIRST SUMMER

Math 343 Advanced Calculus
CE461 Structural Theory and Design
CE493 Special Problems

FALL SEMESTER

CE481 Numerical and Approx. Methods of Structural Analysis
CE486 Investigations in Reinforced Concrete Members
CE493 Special Problems
CE461 Structural Theory and Design
CE373 Int. to Soil Mechanics
TAM421 Mechanics of Materials
TAM461 Inelastic Behavior of Eng. Materials

SPRING SEMESTER

CE482 Buckling, Vibrations and Impact
CE484 Behavior of Structures under Dynamic Load
CE467 Investigations in Reinforced Concrete Members
CE493 Special Problems
CE374 Applied Soil Mechanics
TAM462 Inelastic Behavior of Eng. Materials

The student selects courses from those tabulated above to suit his background needs and to carry the normal load to five units per term.

SECOND SUMMER

CE462 Structural Theory and Design
CE491 Thesis
TAM424 Properties of Eng. Materials

This curriculum affords the opportunity to qualify for the degree of Master of Science in Civil Engineering.

CIVIL ENGINEERING (Advanced)

SANITARY ENGINEERING

(GROUP DESIGNATOR ZGM)

At the University of Michigan

OBJECTIVE

To provide advanced technical instruction for selected CEC officers in the field of water supply and sewerage.

SUMMER

CE120 Fundamentals of Experimental Research
CE152 Water Purification and Treatment
CE131 Cost Analysis and Estimating

FALL

BACT109 Bacteriology for Engineers
CE153 Sewerage and Sewage Disposal
CE155 Municipal and Industrial Sanitation
EH225 Sanitary Chemistry
EH241 Principles and Methods of Industrial Health
CE255 Sanitary Engineering Seminar

SPRING

CE157 Industrial Waste Treatment
CE250 Sanitary Engineering Research
CE254 Advanced Sanitary Engineering Design
PHS231 Statistics Applied to Stream Analysis
NE190 Elements of Nuclear Engineering

This curriculum affords the opportunity to qualify for the degree of Master of Science in Engineering.

CIVIL ENGINEERING (Advanced)

WATERFRONT FACILITIES

(GROUP DESIGNATOR ZGP)

At Princeton University

OBJECTIVE

To provide advanced technical instruction in waterfront development, including planning, design, construction, rehabilitation and maintenance of waterfront facilities.

SUMMER TERM

Mathematics
Strength of Materials
Reinforced Concrete
Fluid Mechanics
Soil Mechanics

FALL TERM

CE505 Advanced Structures
CE511 Waterfront Structures
CE513 Port and Harbor Engineering. Research preparatory to the writing of the thesis
One elective from the following group:
CE501 Soil Stabilization
ME531 Applied Elasticity
ME525 Industrial Management
SOC 544 Urban Sociology

SPRING TERM

CE512 Waterfront Structures
Thesis
Two electives from the following group:
CE502 Soil Mechanics
CE504 Municipal Engineering

CE508 Soil Physics
POLITICS 512 Public Administration

This curriculum affords the opportunity to qualify for the degree of Master of Science.

HYDROGRAPHIC ENGINEERING

(GROUP DESIGNATOR ZV)

At Ohio State University

OBJECTIVE

A one-year course in Hydrographic Engineering given to officers nominated by the Hydrographer. The curriculum presents a sound fundamental theoretical knowledge of geodesy, cartography and photogrammetry, particularly as applied to hydrographic surveying, and the compilation and production of charts and maps. The course majors in one of these three fields in order to enable the graduate to perform future hydrographic duties at the Hydrographic Office, on hydrograpic survey expeditions or on major fleet staffs.

MANAGEMENT AND INDUSTRIAL ENGINEERING

(GROUP DESIGNATOR ZT)

At Rensselaer Polytechnic Institute

To prepare selected officers for managerial and industrial engineering billets in the Navy's industrial organization. The curriculum majors in industrial engineering and its application to managerial problems.

G6.30 Law for Engineers
T6.27 Statistical Methods
T6.32 Work Methods and Standards
T6.28 Cost Finding and Control
G6.44 Production Planning
G6.60 Organization Planning and Development
T63.26 Personnel Tests and Measurement (Industrial Psychometrics)
G6.21 Cost Analysis
G6.45 Production Control
G6.65 Industrial Relations
G6.80 Seminar in Management
or
G6.90 Thesis
G11.85 Intro. to Operations Research
or
G6.70 Special Topics in Management

This curriculum affords the opportunity to qualify for a graduate degree.

METALLURGICAL ENGINEERING

(GROUP DESIGNATOR ZNM)

At Carnegie Institue of Technology

OBJECTIVE

To obtain the maximum possible metallurgical backgroud in a nine-month program designed specifically for the graduate of the Naval Construction and Engineering Curriculum.

FALL SEMESTER

E611 Physical Metallurgy
E641 Ferrous Metallurgy
E645 Metallography Lab.
E647 Non-Ferrous Metallography
E651 Mechanical Metallurgy
E661 Modern Metallurgical Practice
S125 Physical Chemistry
S291 Statistical Quality Control

SPRING SEMESTER

E612 Physical Metallurgy
E642 Ferrous Metallography
E646 Metallography Lab.
E648 Non-Ferrous Metallography
E624 Process Metallurgy
E662 Modern Metallurgy Practice
S126 Physical Chemistry
S292 Statistical Quality Control

This curriculum does not lead to a degree.

NAVAL CONSTRUCTION AND ENGINEERING

(GROUP DESIGNATOR ZNB)

At Massachusetts Institute of Technology and at Webb Institute of Naval Architecture

OBJECTIVE

To qualify officers for naval construction and engineering assignments. Successful completion of this curriculum normally leads to "Engineering Duty" designation.

Hull Design and Construction Subspecialty (XIII-A-1) at M.I.T.

FIRST SUMMER

2.046 Strength of Materials
8.03S Physics (Electricity)
13.20 Elementary Ship Design
M73 Review of Mathematics

FIRST YEAR

FALL

2.081 Strength of Materials
2.402 Heat Engineering
15.11 Introduction to Industrial Management
1.612 Fluid Mechanics
13.17 History of Warships
M351 Adv. Calculus for Engineers

SPRING

1.401 Structures
10.311 Heat Transfer
13.012 Naval Architecture
13.12 Warship General Arrangement
13.21 Warship Form Design
M352 Adv. Calculus for Engineers
Intersessional period: Field trip.

SECOND YEAR

FALL

1;63 Applied Hydromechanics
13.13 Warship Structural Theory I
13.22 Warship General Design
13.75 Warship Propulsion
13.791 Marine Propellers
13.90 Warship Electrical Engineering
3.391 Properties of Metals

SPRING

1.42 Structures
1.683 Experimental Hydromechanics
3.392 Properties of Metals
13.14 Warship Structural Theory II
13.24 Warship Structural Design II
13.76 Warship Propulsion II
N10 Introduction to Nuclear Technology
Intersessional period: Field trip.

THIRD YEAR

FALL

2.126 Experimental Stress Analysis
13.15 Warship Basic Design I
13.16 Warship Basic Design II
13.25 Warship Structural Design II
13.54 Marine Eng. Dynamics
1.561 Advanced Structural Mechanics
Thesis

SPRING

13.26 Preliminary Design of Warships
1.562 Advanced Structural Mechanics
13.04 Ship Design, Advanced
3.15 Welding Engineering
Thesis

This curriculum affords the opportunity to qualify for the degree of Naval Engineer.

Note: Four other subspecialties are offered, all of which contain basic ship design, but proportionately greater amounts of other phases of marine engineering. These are:

XIII-A-2 Marine Electrical Engineering
XIII-A-3 Electronics Engineering
XIII-A-4 Ship Propulsion Engineering
XIII-A-5 Nuclear Engineering

Hull Design and Construction at Webb Institute of Naval Architecture

This three-year curriculum is basically equivalent to the Hull Design and Construction Subspecialty at M.I.T. The schedule provides for a long winter practical work period (field trip), each year, during which the students work in a naval shipyard or other suitable installation.

FIRST SUMMER

Practical Naval Architecture I
Calculus Review
Mechanics Review

FIRST YEAR

Calculus III and IV
Differential Equations
Theoretical Fluid Mechanics I and II
Ship Model Testing
Thermodynamics I
Mechanical Processes
Mechanics of Materials I and II
Laying Off
Practical Naval Architecture II and III
Theoretical Naval Architecture I and II
Naval Architecture Design I and II
Ship Resistance and Propellers I

SECOND YEAR

Engineering Economic Analysis
Industrial Organization
Metallurgy I and II
Advanced Structures I and II
Structural Laboratory
Electrical Engineering IV
Ship Resistance and Propellers II
Elementary Nuclear Physics and Reactors
Theoretical Naval Architecture III
Theory of Warship Design I and II
Warship Design I and II
Thermodynamics II
Marine Engineering III and IV

THIRD YEAR

Advanced Theoretical Fluid Mechanics
Vibrations
Machine Design
Theory of Warship Design III and IV
Warship Design III and IV
Marine Engineering V and VI
Internal Combustion Engines
Nuclear Power in Warship Design
Thesis

This curriculum affords the opportunity to qualify for the degree of Master of Science.

NAVAL INTELLIGENCE

(GROUP DESIGNATOR ZI)

At the U. S. Naval Intelligence School, Washington, D. C.

OBJECTIVE

Nine months of instruction to train selected officers in all phases of intelligence. Following the intelligence course the students normally study a foreign language to qualify as an interpreter-translator. The length of time devoted to language study is dependent upon the language studied and the previous linguistic training of the student.

NUCLEAR ENGINEERING (Advanced)

(GROUP DESIGNATOR ZNE)

At Massachusetts Institute of Technology

OBJECTIVE

To qualify officers for the technical direction of

nuclear power development in the Navy. Graduates of this program can normally expect to be assigned duties within the nuclear power development program under the direction of the Bureau of Ships.

FIRST SUMMER

8.06N Nuclear Physics
M351 Advanced Calculus
M352 Advanced Calculus
8.051 Atomic and Nuclear Physics

FALL

8.531 Nuclear Physics for Engineers I
3,396 Technology of Nuclear Reactor Material
2.522 Heat Transfer, Advanced
N20 Biological Effects of Radiation
N21 Nuclear Reactor Theory I

SPRING

8.532 Nuclear Physics for Engineers II
N23 Nuclear Reactor Engineering
N41 Nuclear Engineering Laboratory I
Thesis

One elective selected from:
N22 Nuclear Reactor Theory II
2.521 Advanced Heat Transfer II
6.67 Nuclear Reactor Control
3.43 Corrosion
3.44 Behavior of Metals at Elev. Temp.

SECOND SUMMER

Thesis

OCEANOGRAPHY

(GROUP DESIGNATED ZO)

At the University of Washington

A twelve-month curriculum to prepare officers for assignment to billes requiring knowledge in the field of oceanography. The curriculum provides a comprehensive theoretical and practical foundation in the various aspects of oceanography, including submarine geology, physical oceanography, chemical oceanography, marine meteorology, and marine biology. A summer period of work at sea and in the laboratory is included. For students with an adequate educational background, this curriculum affords the opportunity to qualify for the degree of Master of Science.

PERSONNEL ADMINISTRATION AND TRAINING

(GROUP DESIGNATOR ZP)

At Stanford University

OBJECTIVE

A one-year curriculum to prepare officers for assignment in personnel administration and supervision or administration of training activities. It includes instruction in Statistical Methods; General, Educational and Social Psychology; General and Educational Sociology; General School Supervision; Counselling Techniques; Guidance; Personnel Management; Administration; Business and Professional Speaking; Personnel Test and Measurements; and Record Studies.

PETROLEUM ENGINEERING

(GROUP DESIGNATOR ZL)

At the University of Pittsburgh and in the petroleum industry

OBJECTIVE

A two-year program consisting of one full year of academic work at the University of Pittsburgh followed by a year in the field with a major oil company. It is designed to equip officers with a broad understanding of the petroleum industry, its problems and economics, for duties with the Naval Petroleum Reserve.

FIRST YEAR

FALL

Pet. Eng. 101 Drilling and Development
Pet. Eng. 104 Business of Oil and Gas Production
Pet. Eng. 105 Petroleum Testing Laboratory
Pet. Eng. 106 Petroleum Production Laboratory
Pet. Eng. 110 Fundamentals of Reservoir Eng.
Chem. Eng. 17 Petroleum Processes
Geology 2 Historical Geology

SPRING

Pet. Eng. 102 Petroleum Production Practice
Pet. Eng. 107 Gathering, Transportation and Storage
Pet. Eng. 108 Reservoir Eng. Seminar
Pet. Eng. 200 Research and Thesis
Pet. Eng. 111 Principles of Natural Gas Engineering
Geology 121 Geology of Oil and Gas
Transportation 109 Principles of Transportation

SUMMER

Pet. Eng. 200 Thesis
Geography 53 World Resources and Industry
or
Ind. Rel. 122 Industrial Relations
or
Commerce 61 Principles of Marketing

SECOND YEAR

Assigned to various petroleum industrial concerns under instruction. This period is devoted to intensive study of operations and procedure in office and field, in close contact with the management.

This curriculum affords the opportunity to qualify for the degree of Master of Science on completion of the summer term of academic work.

PUBLIC INFORMATION

(GROUP DESIGNATOR ZIB)

At Boston University

OBJECTIVE

To advance the qualifications of a small group of officers in public relations. Two officers are trained per year, one for a billet designated 1100 and one for a billet designated 1300. Students enrolled will be experienced naval officers with previous education and/or experience in the fields of public information and public relations. The following is a typical curriculum composed of representative courses which are described in the Boston University Bulletin.

FIRST SEMESTER

PR-441 Publicity: Principles and Practice II
PR-461 Government Relations
PR-701 Contemporary Problems in Public Relations
PR-721 Methods in Social Science Research
PR-741 Propaganda—Its Analysis and Use

SECOND SEMESTER

PR-445 Advanced Techniques in Public Relations Media
PR-702 Contemporary Problems in Public Relations II
PR-761 Factors Influencing Morale
PR-801 Special Problems in Public Relations

SUMMER SESSION

PR-825 Thesis Seminar

This curriculum affords the opportunity to qualify for the degree of Master of Science in Public Relations.

RELIGION

(GROUP DESIGNATOR ZU)

At selected universities

OBJECTIVE

Each student officer enrolled in this curriculum pursues courses of instruction in such subjects as psychology, theology, homiletics, counselling, hospital ministry and education.

An officer selected in this curriculum will be enrolled at Harvard University, Catholic University, University of Chicago, University of Notre Dame, Fordham University, Union Theological Seminary, or the Menninger Foundation, depending on the field of study selected.

SOCIAL SCIENCES

(GROUP DESIGNATOR ZST)

at Tufts University

OBJECTIVE

A two year curriculum to prepare officers of mature judgment and broad background of professional knowledge in the fields of international relations, economics, political science, sociology, geography and history. Leads to a Master's Degree for qualified officers.

SPECIAL MATHEMATICS

OBJECTIVE

A two-year curriculum, sponsored by the Chief of Naval Operations, to further the education of specially selected officers in higher mathematics, with emphasis on mathematical logic, mathematical statistics, and the application of digital computers.

The course has been given at the University of Illinois, and more recently at the Naval Postgraduate School.

JUDGE ADVOCATE OFFICERS ADVANCED COURSE

(GROUP DESIGNATOR ZHV)

at JAG's School (Army), Charlottesville, Virginia

OBJECTIVE

A one year curriculum designed to prepare more experienced officer-lawyers for advanced staff responsibilities in the various legal fields. Course encompasses all branches of military law with emphasis on the administration of justice under the Uniform Code of Military Justice; military affairs; civil affairs arising out of the operation of, or interest to, the military Departments, including claims, civil litigation, and martial law; military reservations; international law, including the law of war; procurement and contract law; and legal assistance to military personnel.

PETROLEUM ADMINISTRATION AND MANAGEMENT

(Gas, Oil and Water Rights)

(GROUP DESIGNATOR ZHS)

at Southern Methodist University

OBJECTIVE

A one year curriculum to prepare officer-lawyers for assignment to billets concerned with the administration and management of the Naval Petroleum Reserves and with the special problems in water rights. This curriculum provides the student with a study of government regulations in oil and gas law taxation problems, and special research and study of the evolution of law concerning water rights, current law affecting these rights, and technical problems encountered.

This course leads to a master degree for qualified officers.

THE ENGINEERING SCHOOL

Description of Courses

Descriptive name of course is followed by two numbers, separated by a hyphen. The first number signifies classroom hours; the second, laboratory hours.

THE ACADEMIC LEVEL OF A COURSE IS INDICATED BY A LETTER IN PARENTHESES AFTER THE COURSE NUMBER AS FOLLOWS:

(A) Full graduate course

(B) Partial graduate course

(C) Undergraduate course

(L) Lecture course—no academic credit

One term credit-hour is given for each hour of lecture or recitation, and half of this amount for each hour of laboratory work. A term credit-hour is equivalent to two thirds of the conventional college semester credit hour because the Engineering School term is of ten-weeks duration in contrast to the usual college semester of 15 or 16 weeks.

AEROLOGY

Mr Courses

Fundamentals of Atmospheric Circulation ----------Mr-100(C)
Aerological Aspects of Atomic, Biological, and Chemical Warfare ----------Mr-110(C)
Operational Aspects of Meteorology and Oceanography ----------Mr-120(C)
Introduction to Meteorology ----------Mr-200(C)
Weather Codes and Elementary Weather-Map Analysis ----------Mr-201(C)
Weather-Map Analysis ----------Mr-202(C)
Upper-Air Analysis and Prognosis ----------Mr-203(C)
Weather Analysis and Forecasting ----------Mr-204(C)
Forecasting Weather Elements and Operational Routines ----------Mr-205(C)
Weather Codes, Maps, and Elementary Weather-Map Analysis ----------Mr-211(C)
Surface and Upper-Air Analysis ----------Mr-212(C)
Upper-Air and Surface Prognosis ----------Mr-213(C)
Advanced Weather Analysis and Forecasting ----------Mr-215(B)
Advanced Weather Analysis and Forecasting ----------Mr-216(B)
Advanced Weather Analysis and Forecasting ----------Mr-217(B)
Tropical Analysis and Forecasting ----------Mr-218(B)
Selected Topics in Applied Meteorology ----------Mr-220(B)
Southern Hemisphere and Tropical Meteorology ----------Mr-228(B)
Selected Topics in Meteorology ----------Mr-229(B)
Operational Forecasting ----------Mr-230(A)
Elementary Dynamic Meteorology I ----------Mr-301(B)
Elementary Dynamic Meteorology II ----------Mr-302(B)
Introduction to Dynamic Meteorology ----------Mr-311(B)
Dynamic Meteorology I ----------Mr-321(A)
Dynamic Meteorology II ----------Mr-322(A)
Dynamic Meteorology III (Turbulence and Diffusion) ----------Mr-323(A)
Introduction to Meteorological Instruments ----------Mr-400(C)
Introduction to Meteorological Thermodynamics ----------Mr-402(C)
Introduction to Micrometeorology ----------Mr-403(B)
Meteorological Instruments ----------Mr-410(C)
Thermodynamics of Meteorology ----------Mr-411(B)
Physical Meteorology ----------Mr-412(A)
The Upper Atmosphere ----------Mr-422(A)
Introduction to Climatology of the Oceans and Atmosphere ----------Mr-500(C)
Climatology ----------Mr-510(C)
Applied Climatology ----------Mr-520(B)
Sea and Swell Forecasting ----------Mr-610(B)
Seminar in Meteorology and Oceanography ----------Mr-810(A)

Mr-100(C) Fundamentals of Atmospheric Circulation 2-0

Primarily designed to give non-aerological officer students a survey of meteorology. The topics included are essentially the same as in Mr-200; however, there is greater emphasis on large-scale and small-scale circulations.

Texts: Taylor: Elementary Meteorology; Petterssen: Introduction to Meteorology.

Prerequisite: None.

Mr-110(C) Aerological Aspects of Atomic, Biological, and Chemical Warfare 3-0

Classified information involving the effects of weather on ABC warfare.

Text: Los Alamos Scientific Laboratory: The Effects of Atomic Weapons.

Prerequisites: Ph-191(C) or equivalent and Mr-203(C) or Mr-212(C).

Mr-120(C) Operational Aspects of Meteorology and Oceanography 3-0

The properties of the atmosphere and the oceans and their distribution; the mean pattern of the general circulation and the seasonal and short-term variations from the mean; methods of predicting atmospheric and oceanographic conditions, and the influence of these conditions on naval operations.

Texts: Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; departmental notes.

Prerequisite: None.

Mr-200(C) Introduction to Meteorology 3-0

A general course which treats descriptively the composition and vertical structure of the atmosphere, physical processes, general circulation, air masses, fronts, cyclones and anticyclones.

Texts: Taylor: Elementary Meteorology; Petterssen: Introduction to Meteorology.

Prerequisite: None.

Mr-201(C) Weather Codes and Elementary Weather-Map Analysis 3-9

Lectures cover atmospheric processes and their graphical representation; classification and charac-

teristics of fronts and cyclones; evaluation of data; techniques of analysis. In the laboratory, methods, instruments, and conventions used in observing and representing graphically the state of the atmosphere at the surface and aloft are discussed and the data encoded for transmission and decoded for plotting. Analysis of a selected series of weather maps is begun. A series of flights is made during which students prepare observed cross sections, learn to use computers, take observations, and copy broadcasts, as well as become familiar with flight problems.

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; NavAer 50-1P-502: Practical Methods ious Navy and Weather Bureau code publications; departmental notes.

Prerequisite: None.

Mr-202(C) Weather-Map Analysis 2-9

A continuation of Mr-201(C). Lectures cover further the three-dimensional aspects of cyclone and frontal structure; upper-air charts; wind, contour, and moisture analysis; differential analysis and advection; large-scale aspects of analysis. In the laboratory, work is continued on a selected series of weather maps. Local weather is observed and daily map discussions held. The weather-flight series is continued from Mr-201(C).

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; departmental notes.

Prerequisites: Mr-200(C) and Mr-201(C).

Mr-203(C) Upper-Air Analysis and Prognosis 2-9

A continuation of Mr-202(C). Lectures cover integrated analysis of the lower and upper troposphere; pressure-change mechanisms, and other features of upper-air prognostic value, including long waves, blocks, cut-off lows, vorticity considerations, short waves, and zonal winds. In the laboratory, students prepare thickness and thermal-advection charts, isotach analyses, and make isobaric height extrapolations. Elementary methods of upper-air prognosis are introduced, and three-dimensional consistency in analysis is stressed. The weather-flight series is continued from Mr-202(C).

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; NavAer 50-1P-502: Practical Methods of Weather Analysis and Prognosis; departmental notes.

Prerequisite: Mr-202(C).

Mr-204(C) Weather Analysis and Forecasting 2-9

A continuation of Mr-203(C). Discussions of upper-air prognostic techniques are continued with more detailed applications of long waves and vorticity to upper-air prognosis; weather types; prognosis at the surface with special emphasis on movement and intensification of surface pressure systems and fronts. Objective and subjective techniques of forecasting weather elements are introduced. In the laboratory, students prepare analyses and prognoses of surface and upper-level charts, stressing time as well as space consistency. Space-mean and geostrophic relative vorticity charts are also constructed. The weather flight series is continued from Mr-203(C).

Texts: Riehl et al: Forecasting in Middle Latitudes; NavAer 50-1P-502: Practical Methods of Weather Analysis and Prognosis; selected NavAer, AROWA, and AWS publications; departmental notes.

Prerequisite: Mr-203(C).

Mr-205(C) Forecasting Weather Elements and Operational Routines 4-0

Lectures cover significance and forecasting of clouds, precipitation, temperature, wind, icing, turbulence, and severe weather; flight forecasting and weather briefing; forecasting for ship and amphibious operations; CAA and general flight manuals, instructions, and supplements; aerological office organization, administration, and operations. Students prepare a climatology study or work on a technical problem.

Texts: NavAer 50-110R-50: Weather Briefing Manual; OpNav Inst 3140.32: Manual of the Aerological Service; other selected publications; departmental notes.

Prerequisites: Mr-213(C) and Mr-400(C).

Mr-211(C) Weather Codes, Maps, and Elementary Weather-Map Analysis 2-12

Lectures include techniques of weather observations and the encoding, decoding, and plotting of data; fundamentals of map analysis; weather-producing processes; graphical representation of atmospheric properties and processes; geostrophic- and gradient-wind scales; representativeness and diurnal variation of meteorological elements; synoptic characteristics of fronts, wave cyclones, and occlusions. An aerology series of motion pictures is shown. In the laboratory, weather data are decoded and plotted, weather observations are made, an elementary series of maps is analyzed, and aircraft flights are made for familiarization.

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; H.O. 206: Radio Weather Aids; various Navy and Weather Bureau code publications; departmental notes.

Prerequisite: None.

Mr-212(C) Surface and Upper-Air Analysis 4-12

Continuation of Mr-211(C). Lectures cover synoptic characteristics of fronts, wave cyclones, and occlusions; upper-air analysis, including temperature fields and the jet stream; graphical arithmetic, thickness and height-change charts, and height extrapolations. The laboratory consists of practice in preparation of sea-level, constant-pressure, and differential charts, with elementary extrapolation techniques of prognosis. A series of flights is made in which students prepare observed cross sections, learn to use computers, take observations, copy broadcasts, and become familiar with flight problems.

Texts: NavAer 50-1P-502: Practical Methods of Weather Analysis and Prognosis; departmental notes.

Prerequisites: Mr-200(C), Mr-211(C), and Mr-402(C).

Mr-213(C) Upper-Air and Surface Prognosis 3-12

Prognostic techniques discussed include mechanisms of pressure change, long-wave and vorticity methods, thickness and continuity charts, movement and development of surface pressure systems, movement of fronts, weather types, air-mass properties and weather, and a checkoff list for general prognostic procedure. Laboratory work includes analysis and prognosis for North America and the adjacent Pacific, both surface and 500 mb., using supplementary charts of pressure changes, vorticity, and stability indices; and forecasts for various selected stations and areas. Flight program same as for Mr-212(C).

Texts: Same as for Mr-212(C).

Prerequisites: Mr-212(C), Mr-311(B), and Mr-403(B) concurrently.

Mr-215(B) Advanced Weather Analysis and Forecasting 2-12*

Lectures concern forecasting of actual operational weather. Topics covered are radiosonde analysis for stability, and frontal and air-mass identification; severe-weather forecasting including tornadoes, hail, turbulence, maximum wind gusts, icing, and operational weather affecting jet aircraft. In the laboratory, analysis of surface and upper-air charts by coordinated teams is introduced; spot and period forecasts are made for selected stations. Weather elements forecasted include surface winds, weather, visibility, and temperatures; upper-level winds, temperatures, and pressure patterns; and ceilings.

Texts: AWSM 105-37: Severe Weather Forecasting; NavAer 00-80T-37: All Weather Flight Manual; selected articles from Monthly Weather Review and AMS publications; departmental notes.

Prerequisite: Mr-204(C).

*Presented as a 2-9 course for the MM Curriculum

Mr-216(B) Advanced Weather Analysis and Forecasting 3-0

Lectures cover general operational weather problems; weather briefing for overseas flight clearances, carrier strikes, and amphibious operations; single-station forecasting; CAA and general flight manuals, instructions, and supplements; fleet and area commanders' instruction; detailed climatology of major areas of interest; aerological office organization, administration, and operations. Students prepare a climatology study or work on a technical problem.

Texts: NavAer 50-110R-50: Weather Briefing Manual; other selected NavAer publications.

Prerequisite: Mr-215(B).

Mr-217(B) Advanced Weather Analysis and Forecasting 0-16*

Students are assigned watches in weather central duties, aerological office routines, and flight forecasting utilizing surface, constant-pressure, jet-stream and isotach analyses; time cross sections, constant absolute-vorticity trajectories, space-mean, pressure-change, and relative-vorticity charts are constructed; daily prognostic surface and upper-air charts are prepared and forecasts made for selected stations; flight cross sections, forecasts, and clearances are prepared for selected over-water and over-land routes; rawinsondes are taken, plotted, and analyzed and experience is gained in teletype, radio-facsimile, and other aerological office routine and operation. A series of maps for tropical areas is analyzed.

Text: None.

Prerequisite: Mr-215(B) or Mr-213(C).

*Presented as a 0-20 course for the M curriculum.

Mr-218(B) Tropical Analysis and Forecasting 0-9

General features of tropical meteorology; time cross sections, streamline analysis; analysis of waves in the easterlies, the intertropical convergence zone, and tropical cyclones; forecasting the formation, movement, and dissipation of tropical cyclones using the latest techniques available.

Texts: Riehl: Tropical Meteorology; AROWA publications.

Prerequisites: Mr-217(B) and Mr-228(B) (may be taken concurrently).

Mr-220(B) Selected Topics in Applied Meteorology 4-0

Tropical and polar meteorology; the general circulation; other topics as time permits.

Texts: Riehl: Tropical Meteorology; Petterssen, Jacobs, and Haynes: Meteorology of the Arctic; NavAer publications; departmental notes.

Prerequisites: Mr-311(B) or Mr-302(B), and Mr-402(C).

Mr-228(B) Southern Hemisphere and Tropical Meteorology 2-0

Southern Hemisphere synoptic meteorology, tropical synoptic models (with emphasis on the tropical cyclone), and tropical forecasting.

Text: Riehl: Tropical Meteorology.

Prerequisite: Mr-321(A) concurrently.

Mr-229(B) Selected Topics in Meteorology 2-0

General circulation of the atmosphere, arctic and antarctic meteorology, extended-range forecasting, and recent developments as time permits.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; selected NavAer and AWS publications.

Prerequisites: Mr-321(A), Ma-125(B), and Ma-330(C).

Mr-230(A) Operational Forecasting 0-10

Presentation and application of recent developments in the technique of preparing prognostic charts. Vorticity and space-mean charts, vertical motion and horizontal divergence computations, numerical forecasting.

Text: Departmental notes.

Prerequisite: Mr-322(A).

Mr-301(B) Elementary Dynamic Meteorology I 4-0

The equations of motion; trajectories and streamlines; thermal wind; mechanism of pressure changes and kinematics of pressure systems.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; departmental notes.

Prerequisites: Mr-200(C), Ph-191(C), and Ma-162(C).

Mr-302(B) Elementary Dynamic Meteorology II 3-0

A continuation of Mr-301(B). Topics covered include frontogenesis; frontal characteristics; vorticity; general circulation.

Texts: Same as for Mr-301(B).

Prerequisites: Mr-301(B), Mr-402(C), and Ma-163(C).

Mr-311(B) Introduction to Dynamic Meteorology 5-0

The equations of motion; trajectories and streamlines; thermal wind; mechanism of pressure changes; kinematics of pressure systems; vorticity.

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; Haltiner and Martin: Dynamical and Physical Meteorology.

Prerequisites: Mr-200(C), Mr-402(C), and Ma-163(C).

Mr-321(A) Dynamic Meteorology I 3-0

The equations of motion in the absolute and relative reference frames. Solutions in particular atmospheric cases. Geostrophic and gradient winds measured in surfaces of constant property. Streamlines and trajectories. The thermal-wind equation in various forms. Surfaces of discontinuity. Solenoids and the circulation theorems.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; Petterssen: Weather Analysis and Forecasting.

Prerequisites: Mr-411(B) and Ma-123(A).

Mr-322(A) Dynamic Meteorology II 3-0

A continuation of Mr-321(A), covering the topics listed below. Continuity and tendency equations. Convergence and divergence in general and in application to circular and wave-shaped systems. The vorticity theorem with applications to certain types of atmospheric flow. Frontogenesis and frontolysis in relation to linear velocity fields. Perturbation techniques in the solution of the equations of motion Numerical integration of the equations of motion.

Texts: Same as for Mr-321(A) plus Haurwitz Dynamic Meteorology.

Prerequisites: Mr-321(A), Ma-125(B), and Ma-330(C).

Mr-323(A) Dynamic Meteorology III (Turbulence and Diffusion) 3-0

The topics presented include the general effects of viscosity and turbulence; the equations of motion for viscous and turbulent flows; diffusion of momentum, and wind variation in the surface layer; diffusion of other properties including heat, water vapor, smoke, etc.; diurnal temperature variation; transformation of air masses.

Text: Sutton: Micrometeorology.

Prerequisites: Mr-321(A), Mr-322(A) concurrently, Ma-125(B), and Ma-330(C).

Mr-400(C) Introduction to Meteorological Instruments 2-0

Basic principles of standard meteorological instru-

ments used in naval aerology for surface and upper-air observations; instrument installation, care, maintenance; and observation techniques.

Texts: OpNav Inst 3140.32: Manual of the Aerological Service; departmental notes.

Prerequisite: Ph-191(C) or equivalent.

Mr-402(C) Introduction to Meteorological Thermodynamics 3-2

A treatment of elementary thermodynamics and its application in meteorology, with particular emphasis on thermodynamic charts and diagrams. Atmospheric stability, instability phenomena, and forecasting techniques are discussed.

Text: Haltiner and Martin: Dynamical and Physical Meteorology.

Prerequisites: Ph-191(C), and Ma-162(C) or equivalent.

Mr-403(B) Introduction to Micrometeorology 3-0

Properties of radiating matter in general; solar and terrestrial radiation and their effects on the temperature distribution in the frictional layer; the heat budget; structure of the wind and its significance in turbulent transfer; air-mass modification; forecasting the micrometeorological variables and their use in diffusion from point and line sources.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; departmental notes.

Prerequisites: Mr-302(B) or Mr-311(B), and Ma-381(C) or equivalent.

Mr-410(C) Meteorological Instruments 2-2

Principles of design and operation of meteorological instruments used in naval aerology with special emphasis on new developments and requirements. Application of electronic meteorological instruments used by the fleet aerologist.

Texts: Middleton and Spilhaus: Meteorological Instruments; selected papers and departmental notes.

Prerequisites: Ma-163(C) or equivalent and Ph-191(C) or equivalent.

Mr-412(A) Physical Meteorology 3-0

Radiation in general. Solar radiation and the measurement of the solar constant. The geographic and seasonal distribution of insolation. Absorption, scattering, and diffuse reflection of solar radiation in the atmosphere. Terrestrial radiation and the atmospheric radiation chart. Computations of atmospheric radiation heat loss or gain. Applications to air-mass modification and to minimum temperature forecasting with arbitrary sky-condition and turbulence effects. The heat budget of the earth-atmosphere system. Selected topics on atmospheric optics and visibility.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; Neuberger: Introduction to Physical Meteorology.

Prerequisite: Mr-411(B) (may be taken concurrently).

Mr-413(B) Thermodynamics of Meteorology 3-2

The physical variables; equations of state; first law of tehrmodynamics; properties of gases; properties of water and moist air; thermodynamic diagrams; air-mass identification indices; geopotential determinations, altimetry; instability phenomena and criteria.

Texts: Molmboe, Forsythe, and Gustin: Dynamic Meteorology; Haltiner and Martin: Dynamical and Physical Meteorology; U. S. Dept. of Commercae; The Thunderstorm.

Prerequisites: Ma-131(C) and Ph-196(C).

Mr-422(A) The Upper Atmosphere 5-0

The composition of the upper atmosphere. The nature of the upper atmosphere as determined from several lines of observation. The ionosphere and related optical and electrical activity. The sun and its effect on the atmosphere. Terrestrial magnetic variations. Atmospheric oscillations of tidal origin. The aurora.

Texts: Mitra: The Upper Atmosphere; Johnson: Physical Meteorology; departmental notes.

Prerequisites: Ma-331(A) and Mr-323(A).

Mr-500(C) Introduction to Climatology of the Oceans and Atmosphere 3-0

Introduction to oceanography. Physical properties of sea water and their distributions; heat budget of the oceans; horizontal and vertical oceanic circulations. Interaction of the oceans and atmosphere. Distribution of the major meteorological elements with respect to season, geography, and orography. Definitions of climatic zones and types according to Koppen, and their meteorological descriptions, with applications.

Texts: Sverdrup: Oceanography for Meteorologists; Haurwitz and Austin: Climatology; Berry, Bollay, and Beers: Handbook of Meteorology.

Prerequisite: Mr-200(C).

Mr-510(C) Climatology 2-0

The distribution with respect to season, geography, and orography of the major meteorological elements. Definitions of climatic zones and types according to Koppen, and their meteorological descriptions. Micrometeorology. Regional climatology of the oceans. Climatology as a tool in objective forecasting.

Text: Haurwitz and Austin: Climatology.

Prerequisite: Mr-200(C).

Mr-520(B) Applied Climatology 2-2

Review of methods of classifying climates. Synoptic climatology. Statistical evaluation of climatological data. Methods of presenting climatological data to non-aerological personnel. Objective forecasting techniques. Application of above during laboratory period.

Texts: Conrad and Pollack: Methods in Climatology; Jacobs: Wartime Developments in Applied Climatology.

Prerequisites: Mr-510(C) or equivalent and Ma-331(A).

Mr-610(B) Sea and Swell Forecasting 2-2

Lectures cover the generation, propagation, and dispersion of ocean waves; statistical properties of waves; and shoaling and refraction. Wind waves and swell are forecast from meteorological data in the laboratory.

Texts: H.O. 603: Practical Methods for Observing and Forecasting Ocean Waves; H.O. 604: Techniques for Forecasting Wind Waves and Swell; H.O. 234: Breakers and Surf.

Prerequisites: Mr-212(C) or equivalent, and Ma-381(C) or equivalent concurrently.

Mr-810(A) Seminar in Meteorology and Oceanography 2-0

Students study and prepare synopses of current publications or original data concerning meteorology or oceanography and present them for group discussion.

Text: None.

Prerequisites: Mr-422(A), Mr-520(B), Ma-331(A), and Ma-421(A).

AERONAUTICS

Ae Courses

Aeronautical Lecture Series ----------Ae-001(L)
Aeronautical Lecture Series ----------Ae-002(L)
Basic Aerodynamics ----------Ae-100(C)
Technical Aerodynamics ----------Ae-121(C)
Technical Aerodynamics—Performance I -Ae-131(C)
Aircraft Performance—Flight Analysis---Ae-136(B)
Dynamics I ----------Ae-141(A)
Dynamics II ----------Ae-142(A)
Dynamics ----------Ae-146(A)
Flight Testing and Evaluation I----------Ae-151(B)
Flight Testing and Evaluation II--------Ae-152(B)
Flight Testing and Evaluation III--------Ae-153(B)
Flight Testing and Evaluation Laboratory I ----------Ae-161(B)
Flight Testing and Evaluation Laboratory II ----------Ae-162(B)
Flight Testing and Evaluation Laboratory III ----------Ae-163(B)
Rigid Body Statics ----------Ae-200(C)
Strength of Materials ----------Ae-211(C)
Stress Analysis I ----------Ae-212(C)
Stress Analysis II ----------Ae-213(B)
Stress Analysis III ----------Ae-214(A)
Advanced Stress Analysis ----------Ae-215(A)
Airplane Design I ----------Ae-311(C)
Airplane Design ----------Ae-316(C)
Thermodynamics I (Aeronautical) ------Ae-409(C)
Thermodynamics II (Aeronautical) --- --Ae-410(B)
Aircraft Engines ----------Ae-411(B)
Aircraft Propulsion ----------Ae-421(B)
Aerothermodynamics of Turbomachines -Ae-431(A)
Gas Turbines I ----------Ae-451(A)
Gas Turbines II ----------Ae-452(A)
Advanced Problems in Gas Turbines I ---Ae-453(A)
Advanced Problems in Gas Turbines II --Ae-454(A)
Hydro-Aero Mechanics I----------Ae-501(A)
Hydro-Aero Mechanics II ----------Ae-502(A)
Compressibility I ----------Ae-503(A)
Compressibility II ----------Ae-504(A)
Compressibility ----------Ae-508(A)

Ae-001(L) Aeronautical Lecture Series 0-2

Lectures on general aeronautical engineering subjects by prominent authorities from the Bureau of Aeronautics, research laboratories and the industry.

Text: None.

Prerequisite: None.

Ae-002(L) Aeronautical Lecture Series 0-1

Lectures on electrical engineering subjects in connection with aeronautical engineering by prominent authorities from the Bureau of Aeronautics, research laboratories, and the industry.

Text: None.

Prerequisite: None.

Ae-100(C) Basic Aerodynamics 3-4

Properties of fluids; statics; velocity and pressure; Bernoulli's theorem; cavitation; theory of lift; blade screws and propellers; viscous flows; vortices; laminar and turbulent boundary layer flows; separation phenomena; surface friction; resistance of floating bodies; dynamics of compressible fluids. The laboratory periods include experimental work in the wind tunnel, allied to the topics above; technical analysis and report writing.

Texts: Dodge, Thompson: Fluid Mechanics; Rouse: Elementary Fluid Mechanics.

Prerequisite: None.

Ae-121(C) Technical Aerodynamics 3-2

Characteristic flows and pressures about bodies; surface friction; wake drag; aerodynamic characteristic of airfoil sections; three-dimensional airfoil theory; induced drag; interference drag; high lift devices; velocity polar. The laboratory periods include wind tunnel experiments, analysis and technical report writing on topics allied to the above class work.

Texts: Dwinnell: Principles of Aerodynamics; Pope: Wind Tunnel Testing.

Prerequisite: Ae-100(C).

Ae-131(C) Technical Aerodynamics Performance I 4-2

The aerodynamic characteristics of the airplane; propeller and jet engine characteristics; sea level performance; performance at altitudes; range and endurance; special performance problems; charts. The laboratory periods are devoted to computations and performance analysis.

Text: Perkins and Hage. Airplane Performance, Stability and Control.

Prerequisite: Ae-121(C).

Ae-136(B) Aircraft Performance—Flight Analysis 3-2

Aerodynamic characteristics of composite aircraft; propeller and engine characteristics; aircraft per-

formance; range and endurance; special performance problems; performance parameters; flight test reduction and analysis. Laboratory analysis of performance of an aircraft will be made based upon wind tunnel tests; analysis of practical problems from flight test.

Texts: Pope: Wind Tunnel Testing; Hamlin: Flight Testing.

Prerequisite: Ae-121(C).

Ae-141(A) Dynamics I 3-4

Fundamental definitions; the forces and moments on the entire airplane; the equations of motion; the moments of the wing, tail and other parts of the airplane; C.G. location, effect on static stability; neutral points; maneuver points; fixed control and free control stability; elevator, aileron, rudder effectiveness; control design features; maneuverability and controllability; turns and loops. The laboratory work consists of wind tunnel experimentation and analysis of the above topics on models.

Texts: Higgins: USNPGS Notes; Perkins: Aircraft Stability and Controllability; Hamlin: Flight Testing.

Prerequisite: Ae-131(C).

Ae-142(A) Dynamics II 3-4

The Euler equations of motion; the moments of inertia of aircraft; the aerodynamic reactions and derivatives; solution of the symmetrical or longitudinal motion analysis; solution of the asymmetrical or lateral motion analysis; effect of control freedom, of controls and response; spins. The laboratory work consists of wind tunnel experimentation on models to study some of the above problems.

Texts: The same as in Ae-141(A).

Prerequisite: Ae-141(A).

Ae-146(A) Dynamics 3-2

Fundamental definitions, forces and moments of composite aircraft; equations of motion; static stability and trim; effects of CG location; static margins; free control stability; dynamic longitudinal stability; dynamic lateral stability, force and moment; derivatives; stability charts; controllability; maneuverability; three-dimensional motions; spins. Laboratory work consists of experimentation and analysis of static and dynamic stability of some particular aircraft.

Texts: Same as in Ae-141(A).

Prerequisite: Ae-131(C) or Ae-136(B).

Ae-151(B) Flight Testing and Evaluation I 2-0

The technical aerodynamics of airplanes, especially performance and test methods.

Texts: Dommasch, Sherby and Connolly: Airplane Aerodynamics; NATC Patuxent, Flight Test Manual; NavAer publications.

Prerequisite: Ae-132(B).

Ae-152(B) Flight Testing and Evaluation II 2-0

Theoretical longitudinal stability and control of aircraft, related test methods and aircraft evaluation.

Texts: Same as Ae-151(B).

Prerequisites: Ae-141(A) or Ae-146(A).

Ae-153(B) Flight Testing and Evaluation III 2-0

Theoretical lateral-directional control of aircraft, related test methods and aircraft evaluation.

Texts: Same as Ae-151(B).

Prerequisite: Ae-142(A) or Ae-146(A).

Ae-161(B) Flight Testing and Evaluation Laboratory I 0-4

Flight program accompanying Ae-151(B). Test flying in naval aircraft by aviator students and reduction of resulting data: airspeed calibration; level flight performance and fuel consumption; climb performance.

Ae-162(B) Flight Testing and Evaluation Laboratory II 0-4

Flight program accompanying Ae-152(B). Test flying in naval aircraft by aviator students: stalls; static and dynamic longitudinal stability; static and maneuvering neutral points; control effectiveness; trim changes; Mach effects.

Ae-163(B) Flight Testing and Evaluation Laboratory III 0-8

Flight program accompanying Ae-153(B). Test flying in naval aircraft by aviator students: rate of roll; adverse yaw; control effectiveness with asymmetric power; static and dynamic lateral-directional stability; over-all qualitative evaluation of aircraft.

Ae-200(C) Rigid Body Statics 3-2

This course parallels Mc-101, extending the coverage of rigid body statics graphically and analytically to meet design requirements of aircraft components. Topics include: plane, compound and complex trusses; centroids, moments of inertia, properties of aircraft sections; moments of inertia of aircraft, balance diagrams; simple, compound and complex space frames; load lines, shear and bending moment diagrams; influence lines.

Texts: Bruhn: Analysis and design of Airplane Structures; Niles and Newell: Airplane Structures, 3rd Ed., Vol. 1; Timoshenko and Young: Statics.

Prerequisites: To be taken with Mc-101, with same prerequisite.

Ae-211(C) Strength of Materials 4-0

Elastic body analysis applied to aircraft structures and machines. Topics are: the elementary state of stress in ties, struts, shear members, circular shafts, simple beams, short beam-struts, cores, simple columns, thin cylinders; extended discussion of deflection of straight beams, frames with straight members; statically indeterminate cases using diagrammatic and moment-distribution methods.

Texts: Bruhn: Analysis and Design of Airplane Structures; Niles and Newell: Airplane Structures, 3rd Ed., Vol. I; Timoshenko: Strength of Materials, Vol. I.

Prerequisite: Ae-200(C).

Ae-212(C) Stress Analysis I 4-2

The general state of plane stress in complicated components of air frames and machines, and the stability of continuous beam columns. Topics are: plane stress, principal stresses, Mohr circle of stress, stress ellipse; shear stress developed in bending, effect on deflection; shear flow in bending under transverse loads, center of twist; bending of beams with open or hollow sections; torsion of shafts of non-circular section, membrane analogy, torsional shear flow; torsion and bending; built-up beams, shear-resistant webs, tension field webs, wooden beams; beam-columns and ties.

Texts: Bruhn: Analysis and Design of Airplane Structures; Niles and Newell: Airplane Structures, Vols. I and II; Timoshenko: Strength of Materials, Vols. I and II.

Prerequisite: Ae-211(C)

Ae-213(B) Stress Analysis II 4-2

A continuation of Ae-212. Strain energy, curved bars and frames. Topics are: strain energy, applications to impact loading; Castigliano theorem; displacements in trusses, trusses with redundant members; virtual energy applications, Maxwell-Mohr method; law of reciprocal deflection, influence line applications; energy methods applied to buckling; curved bars, stresses and deflections; rotating machine parts.

Texts: The same as in Ae-212(C).

Prerequisite: Ae-212(C).

Ae-214(A) Stress Analysis III 3-0

A continuation of Ae-213. The general three dimensional state of stress, strain and displacement in elastic media. Thin stiff plates under lateral load in bending. Axially symmetrical plates and membranes. Discontinuity effects in shells. Beams on elastic foundation, applications to cylinder and hemisphere or flat plate or hollow ring. Thick walled spheres and cylinders under inner and outer pressures, application to rotating discs.

Texts: The same as in Ae-213(B).

Prerequisite: Ae-213(B).

Ae-215(A) Advanced Stress Analysis 4-0

A continuation of Ae-214. Rectangular plates in pure bending, in bending and under middle surface loading; buckling, crippling; selected topics from theory of elasticity and plasticity; advanced stability considerations.

Texts: The same as in Ae-214 plus Sechler and Dunn: Airplane Structural Analysis and Design.

Prerequisite: Ae-214(A).

Ae-311(C) Airplane Design I 2-4

Detail methods of design and analysis of a jet airplane. Preliminary layout, three-view drawing, weight and balance; aerodynamic characteristics and basic performance; flight loads from V-n diagram; dynamic balancing; wing shear and moment curves; detail structural design of wing.

Texts: The same as A-213(B); also Corning, Airplane Design; Sechler and Dunn: Airplane Structural Analysis and Design; Bureau of Aeronautics Specifications NAVAER SS-1C.

Prerequisite: Ae-213(B).

Ae-312(B) Airplane Design II 1-4

A continuation of Ae-311(C). Stress analysis of wing including: stringer stresses; shear flows; skin stresses and skin buckling check; semi-tension field analysis of front spar web, spar caps, stiffners. Analysis of riveted, bolted, welded fittings.

Texts: Same as Ae-311(C).

Prerequisite: Ae-311.

Ae-316(C) Airplane Design 2-4

Detail methods of airplane or missile design and analysis. Preliminary layout; three view drawing; weight and balance; aerodynamic characteristics and basic performance; design criteria; inertia loads; wing shear and moment curves; detail structural design and stress analysis of wing including stringer stresses, shear flow, skin buckling check, semi-tension field analysis of front spar.

Texts: The same as Ae-213(B); also Corning, Airplane Design.

Prerequisite: Ae-213(B).

Ae-409(C) Thermodynamics I (Aeronautical) 4-2

Fundamentals of thermodynamics edited especially for application to aerothermodynamics and aircraft propulsion. Topics include fundamental laws, energy concepts, terminology and symbolism, properties of gases and vapors, property relationships, theoretical cycles and elementary compressible flow.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Keys: Thermodynamic properties of Steam; Keenan and Kaye: Gas Tables.

Prerequisite: Ae-100(C).

Ae-410(B) Thermodynamics II (Aeronautical) 3-2

This course extends the study of fundamental thermodynamics in preparation for advanced work in aerothermodynamics and aircraft propulsion. Topics include one-dimensional compressible flow, internal combustion engine and turbine cycles and elements of heat transfer.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Stoever: Applied Heat Transmission; Keenan and Kaye: Gas Tables.

Prerequisite: Ae-409(C).

Ae-411(B) Aircraft Engines 4-2

This course extends the study of combustion with particular reference to piston engine and gas turbine applications. Topics are: fuel mixtures; ignition; flame propagation and stability; utilization, conversion and mechanical aspects; survey of current engine design and construction.

Texts: Lichty: Internal Combustion Engines; Taylor and Taylor: Internal Combustion Engines; USNPGS Notes.

Prerequisite: Ae-410(B).

Ae-412(B) Thermodynamics Laboratory 0-3

Laboratory experiments and computations involving air flow, combustion, gas analysis and heat tranfer as applied to aircraft propulsion machinery. Familiarization with and use of specialized instrumentation.

Text: None.

Prerequisite: To be accompanied by Ae-411(B).

Ae-421(B) Aircraft Propulsion 3-2

Sea level and altitude performance characteristics of piston engines, propellers, turbo-jet and turbo-prop engines. Topics are: maximum performance; cruise control; laboratory and flight testing; test data correction methods; aircraft performance review with particular reference to the propulsion system. The practical work of this course consists of supervised analysis of test data taken at various Naval Air Test Centers.

Texts: Fraas: Aircraft Power Plants; Nelson: Airplane Propeller Principles; Godsey and Young: Gas Turbines for Aircraft; Sutton: Rocket Propulsion Elements.

Prerequisite: Ae-411(B).

Ae-428(A) Operating Principles of Turbomachines 3-2

General relations for flows with energy changes, relative and absolute motions, momentum theorem. Operating principles of axial-flow and centrifugal machines, compressors and turbines. Operating characteristics to establish relations between theoretical and actual performance in special compressor test rig.

Text: USNPS Notes.

Prerequisite: Ae-411(B), and accompanied by Ae-508(A).

Ae-431(A) Aerothermodynamics of Turbomachines 4-1

Fundamental course of the study of flows of elastic fluids in turbomachines. Topics are: absolute and relative fluid motions; equations of motions and energy equations for actual fluids; momentum theorems for absolute and relative flows; flow in cascades; operating principles of turbomachines; axial-flow compressors; mixed-flow and centrifugal compressors; axial-flow turbines; centripetal turbines. The laboratory periods are devoted to measurements and analysis of flow phenomena in an especially instrumented Compressor Test Rig.

Text: USNPGS Notes.

Prerequisites: Ae-503(A).

Ae-451(A) Gas Turbines I 3-0

Thermodynamic studies of gas turbine cycles; free-piston plants; part load performance; heat transfer and losses in regenerators; control problems; design features; operating experiences.

Text: USNPGS Notes.

Prerequisite: Ae-431(A).

Ae-452(A) Gas Turbines II 3-0

Advanced aerothermodynamics; three-dimensional flow phenomena; analysis and design of bladings; analysis and design of turbomachines and gas turbines with emphasis on rational methods and future developments.

Text: USNPGS Notes.

Prerequisite: Ae-451(A).

Ae-453(A) Advanced Problems in Gas Turbines I

Discussion and solution of original problems of theoretical or experimental nature.

Hours to be arranged.

Texts: As required.

Prerequisite: Ae-452(A).

Ae-454(A) Advanced Problems in Gas Turbines II

Hours to be arranged.

Continuation of Ae-453(A).

Ae-501(A) Hydro-Aero Mechanics I 4-0

This is the first of a sequence of four courses which study in detail the rational mechanics of fluid media; Vector calculus and aerodynamical applications; fluid kinematics and flow description; stream and velocity potential functions; dynamic equations for a perfect fluid; solution by scalar and vector methods; properties of elemental and combined flows; two-dimensional problems; use of complex numbers in flow description; conformal transformation; complex integration; Blasius equations; Kutta-Joukowski theorem; lift and pitching moment on an infinite wing.

Texts: Streeter: Fluid Dynamics; Kuethe and Schetzer: Foundations of Aerodynamics; Abbott and von Doenhoff: Theory of Wing Sections.

Prerequisite: Ae-131(C).

Ae-502(A) Hydro-Aero Mechanics II 4-0

Helmholtz vortex theory; the three-dimensional airfoil; induced velocity, angle of attack, drag; lift distribution; least induced drag; tapered and twisted wings; Chordwise and spanwise load distribution, tunnel-wall effect; viscous fluids: Navier-Stokes Equations, Prandtl boundary layer equations, Blasius solution, Karman integral relation.

Texts: The same as in Ae-501(A).

Prerequisite: Ae-501(A).

Ae-503(A) Compressibility I 4-0

Compressible flow; thermodynamic fundamentals; adiabatic flow equations; propagation of plane disturbances; one-dimensional channel flow; oblique shock waves and shock reflections; optical measurement techniques.

Texts: Kuethe and Schetzer: Foundations of Aerodynamics; Liepmann and Puckett: Aerodynamics of a Compressible Fluid; Sauer: Theoretical Gas Dynamics; Ferri: Elements of Aerodynamics of Supersonic Flow.

Prerequisites: Ae-410(B) and Ae-502(A).

Ae-504(A) Compressibility II 3-2

Two and three-dimensional compressible flows; two-dimensional linearized theory and application to airfoils in compressible flow; three-dimensional linearized theory; hodograph methods; method of characteristics; exact solutions in two-dimensional flow; transonic flow problems; similarity laws for transonic and hypersonic flows; viscous shear and heat transfer, boundary layer in compressible flows. Transonic and supersonic wind tunnel tests are conducted in conjunction with class discussion.

Texts: The same as in Ae-503(A).

Prerequisite: Ae-503(A).

Ae-508(A) Compressibility 3-2

Thermoaerodynamic fundamentals of flow in compressible fluids; adiabatic equations; propagation of plane disturbances; one-dimensional channel flow; oblique shock waves, reflections; two-dimensional compressible flows; linearized theory and application to airfoils in compressible flow; method of characteristics; three-dimensional linearized theory; similarity laws; viscous compressible flow and heat transfer. Laboratory periods are used in transonic and supersonic wind tunnel tests and in measurements by optical instrumentation.

Texts: The same as in Ae-503(A).

Prerequisites: Ae-410(B) and Ae-502(A).

BIOLOGY

Bi Courses

General Biology ----------Bi-800(C)
Animal Physiology ----------Bi-801(B)
Radiation Biology ----------Bi-802(A)
Biological Effects of Radiation ----------Bi-810(C)

Bi-800(C) General Biology 6-0

General botany, zoology, animal physiology, biochemistry, genetics, and ecology.

Text: Villee: Biology.

Prerequisite: Ch-315(C).

Bi-801(B) Animal Physiology 6-0

A general course in animal physiology, emphasizing human functional aspects.

Text: Winton and Bayliss: Human Physiology.

Prerequisite: Bi-800(C).

Bi-802(A) Radiation Biology 6-0

Physiological and genetic effects of radiation and blast. Calculation and measurement of dose; methods of experimental radiobiology.

Text: Bacq and Alexander: Fundamentals of Radiobiology.

Prerequisites: Ph-642(B); Bi-801(B).

Bi-810(C) Biological Effects of Radiation 3-0

Principles of biological dose measurement. Tolerance levels; genetic and physiological effects of ionizing radiations.

Text: Spear: Radiation and Living Cells.

Prerequisite: Ph-640(B).

CHEMISTRY AND CHEMICAL ENGINEERING

Ch Courses (Chemistry) and CE Courses (Chemical Engineering)

General Inorganic Chemistry ..... Ch-101(C)
General Inorganic Chemistry ..... Ch-102(C)
Elementary Physical Chemistry ..... Ch-103(C)
Fuel and Oil Chemistry ..... CE-111(A)
General and Petroleum Chemistry ..... Ch-121(B)
Quantitative Analysis ..... Ch-213(C)
Qualitative Analysis ..... Ch-221(C)
Qualitative Analysis ..... Ch-222(C)
Quantitative Analysis ..... Ch-231(C)
Organic Chemistry ..... Ch-301(C)
Organic Chemistry ..... Ch-311(C)
Organic Chemistry ..... Ch-312(C)
Organic Chemistry ..... Ch-315(C)
Organic Qualitative Analysis ..... Ch-321(A)
Organic Chemistry Advanced ..... Ch-322(A)
The Chemistry of High Polymers ..... Ch-323(A)
Physical Chemistry (Ord.) ..... Ch-401(A)
Physical Chemistry ..... Ch-411(C)
Physical Chemistry ..... Ch-412(C)
Physical Chemistry Advanced ..... Ch-413(A)
Physical Chemistry ..... Ch-414(C)
Physical Chemistry ..... Ch-415(C)
Physical Chemistry ..... Ch-442(C)
Plastics ..... CE-521(A)
Physical Chemistry (for Metallurgy Students) ..... Ch-531(A)
Reaction Motors ..... CE-541(A)
Radiochemistry ..... Ch-551(A)
Radiochemistry ..... Ch-552(A)
Nuclear Chemical Technology ..... CE-553(A)
Chemistry of Nuclear Fuels ..... Ch-554(A)
Physical Chemistry ..... Ch-561(A)
Explosives ..... Ch-571(A)
Chemistry of Special Fuels ..... Ch-581(A)
Blast and Shock Effects ..... CE-591(A)
Thermodynamics ..... CE-611(C)
Thermodynamics ..... CE-612(C)
Chemical Engineering Thermodynamics ..... CE-613(A)
Chemical Engineering Thermodynamics ..... CE-631(A)
Chemical Engineering Calculations ..... CE-701(C)
Chemical Engineering Calculations ..... CE-711(C)
Unit Operations ..... CE-721(B)
Unit Operations ..... CE-722(A)
Petroleum Refinery Engineering ..... CE-731(A)
Petroleum Refinery Engineering ..... CE-732(A)
Chemistry Seminar ..... Ch-800(A)

Ch-101(C) General Inorganic Chemistry 3-2

A study of the principles governing the chemical behavior of matter. Includes topics such as kinds of matter, stoichiometric calculations, utility of the mole concept, kinetic theory, atomic structure, speed of chemical reactions, chemical equilibrium, introduction to organic chemistry and specialized topics (explosives, corrosion, etc.). Elementary physical chemistry experiments such as determination of molecular formulas, pH, reaction rates, etc., are performed in the laboratory.

Text: Hildebrand: Principles of Chemistry.

Prerequisite: None.

Ch-102(C) General Inorganic Chemistry 4-2

Topics include properties of matter, atomic and molecular structure, valence, weight relations in chemical reactions, oxidation-reduction, electrochemistry, gases, solutions, chemical equilibrium, reactions of metallic ions and ionic equilibria encountered in qualitative analysis. The laboratory work is qualitative analysis performed on a semimicro scale.

Texts: Pauling: General Chemistry; Curtman: Introduction to Semimicro Qualitative Analysis.

Prerequisite: None.

Ch-103(C) Elementary Physical Chemistry 3-2

A course in theoretical chemistry for operations analysis curriculum; a study of principles governing the behavior of matter when subjected to various influences. Modern concept of the structure of matter, kinetic theory, dynamic equilibria in various systems, etc. In the development of the subject the mathematical approach is emphasized. Discussion of the various topics utilizes examples selected from situations of interest to officers in the military services.

The laboratory work consists of experiments, largely quantitative, illustrating the principles discussed in the lectures.

The course is designed to serve both as a refresher and a terminal background course for officers whose major interest lies in fields other than chemistry, physics, or related sciences.

Text: Hildebrand: Principles of Chemistry.

Prerequisite: None.

CE-111(A) Fuel and Oil Chemistry 2-2

The occurrence, classification and refining of petroleum, theory of combustion of fuels, theory of lubrication, physical and chemical properties of fuels and lubricants and their correlation with performance, and the analysis of Orsat data. Laboratory work consists of conducting standard tests on fuels and lubricants, and Orsat analysis of combustion gases.

Text: Gruse and Stevens: Chemical Technology of Petroleum; Pugh and Court: Fuels and Lubricating Oils.

Prerequisite: Ch-101(C).

Ch-121(B) General and Petroleum Chemistry 4-2

Topics covered in this course are: classification of matter, atomic theory, atomic structure, gas laws, thermochemistry, chemical equilibria, chemical kinetics, elementary stoichiometry, organic chemistry, occurrence, classification and refining of petroleum, theory of combustion, theory of lubrication, physical and chemical properties of fuels and lubricants and their correlation with performance, and analysis of Orsat data. Laboratory work consists of experiments illustrating topics covered in lectures and standard tests on fuels and lubricants.

Texts: Hildebrand: Principles of Chemistry; Pugh and Court: Fuels and Lubricating Oils; Gruse and Stevens: Chemical Technology of Petroleum.

Prerequisite: None.

Ch-213(C) Quantitative Analysis 2-3

A review of the theoretical principles underlying analytical chemical methods, and the calculations involved in quantitative determinations. The laboratory work consists of typical volumetric and gravimetric determinations.

Text: Pierce and Haenisch: Quantitative Analysis.

Prerequisite: Ch-102(C).

Ch-221(C) Qualitative Analysis 3-2

The first part of a course in analytical chemistry, including the treatment of ionization, chemical equilibrium, solubility product, complex-ion formation and oxidation-reduction reactions, as they apply to qualitative analysis. The laboratory work consist of the separation and detection of selected ions on a semimicro scale.

Text: Curtman: Introduction to Semimicro Qualitative Analysis.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-222(C) Qualitative Analysis 2-2

A brief course, in which separation and detection of selected cations on a semimicro scale is used as a basis for the study of acid-base systems, chemical equilibrium, solubility product, complex ions, hydrolysis, and oxidation-reduction reactions.

Text: Curtman: Introduction to Semimicro Qualitative Analysis.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-231(C) Quantitative Analysis 2-4

A continuation of Ch-221(C), dealing with the principles and calculation involved in quantitative analysis. The laboratory work consists of typical volumetric and gravimetric determinations.

Text: Pierce and Haenisch: Quantitative Analysis.

Prerequisites: Ch-101(C) or Ch-121(B) and Ch-221(C).

Ch-301(C) Organic Chemistry 3-2

An introduction to the properties, reactions and relationships of the principal classes of aliphatic and aromatic organic compounds. The laboratory work includes preparative experiments and experiments illustrating typical organic reactions.

Text: Schwenck and Martin: Basic Organic Chemistry.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-311(C) Organic Chemistry 3-2

The first half of a course in organic chemistry, consisting of the study of the properties and reactions of aliphatic compounds. The laboratory work is designed to illustrate typical organic reactions.

Text: Brewster: Organic Chemistry—A Brief Course.

Prerequisite: Ch-101(C).

Ch-312(C) Organic Chemistry 3-2

A continuation of Ch-311(C), dealing chiefly with aromatic compounds. Organic synthetic methods are emphasized in the laboratory.

Text: Brewster: Organic Chemistry—A Brief Course.

Prerequisite: Ch-311(C).

Ch-315(C) Organic Chemistry 3-2

An introduction to the properties, reactions and relationships of the principal classes of organic compounds, as a basis for work in the biological sciences.

Text: Schwenck and Martin: Basic Organic Chemistry.

Prerequisite: Ch-102(C).

Ch-321(A) Organic Qualitative Analysis 2-2

Identification of organic compounds on the basis of physical properties, solubility behavior, classification reactions and the preparation of derivatives.

Text: Shriner and Fuson: Identification of Organic Compounds.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C).

Ch-322(A) Organic Chemistry, Advanced 3-2

A more detailed consideration of reactions used in organic syntheses, with particular attention to reaction mechanisms and electronic configurations.

Text: Royals: Advanced Organic Chemistry.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C).

Ch-323(A) The Chemistry of High Polymers 3-0

Mechanism of polymerization; addition and condensation polymers; phenoplastics; aminoplastics; elastomers; natural high polymers and their modification; structure and physical properties of high polymers.

Text: Ritchie: Chemistry of Plastics and High Polymers.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C) and Ch-521(A).

Ch-401(A) Physical Chemistry 3-2

Physical chemistry for ordnance students; a study of the laws governing behavior of matter. Gases, liquids, solids, chemical kinetics, thermochemistry, and chemical thermodynamics with emphasis placed on chemical equilibrium in gaseous mixtures. Numerical problems on gas mixtures, equilibria in explosion products, and flame temperatures form an integral part of the course.

The laboratory work consists of experiments illustrating principles discussed in the lectures.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews and Williams: Experimental Physical Chemistry.

Prerequisites: Ch-101(C) or equivalent and Ch-613(A) or equivalent.

Ch-411(C) Physical Chemistry 3-2

Gases, solids, physical properties and molecular structure, thermodynamics, thermochemistry, liquids and solutions. The laboratory work consists of experiments which illustrate principles discussed in the lectures.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams: Experimental Physical Chemistry.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-412(C) Physical Chemistry 3-2

Continuation of Ch-411(C). Chemical equilibrium, chemical kinetics, electrical conductance, electromotive force, colloids and atomic and nuclear structure. Related laboratory work is included.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams: Experimental Physical Chemistry.

Prerequisite: Ch-411(C).

Ch-413(A) Physical Chemistry (Advanced) 2-2

A graduate course covering selected topics in physical chemistry, such as electrochemistry, electronic configurations and dipole moments, and the physical chemistry of the solid and liquid states. The laboratory work supplements the material covered in the lectures and introduces the student to problems and techniques encountered in research.

Text: To be assigned.

Prerequisites: Two terms of physical chemistry, one term of thermodynamics.

Ch-414(C) Physical Chemistry 3-2

This is the first course of a two-term sequence in Physical Chemistry designed for students specializing in radiology. Topics covered include the gaseous, liquid, and solid states; chemical thermodynamics; thermochemistry, and the properties of solutions. The laboratory work consists chiefly of quantitative analysis.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Pierce and Haenish: Quantitative Analysis.

Prerequisite: Ch-102(C).

Ch-415(C) Physical Chemistry 3-2

This course is a continuation of the Physical Chemistry sequence designed for students majoring in radiology. Topics covered are chemical equilibria, chemical kinetics, electrical conductance, electromotive force, colloids, atomic and nuclear structure and cryogenics. Laboratory work is related to the subject matter.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-414(C).

Ch-442(C) Physical Chemistry 4-2

A short course in physical chemistry for chemistry majors. Gases, solids, thermochemistry, liquids, solutions, chemical equilibrium, chemical kinetics, electrochemistry and colloids. Laboratory experiments which illustrate principles discussed in the lectures are performed.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-101(C) or equivalent.

CE-521(A) Plastics 3-2

A study of the nature of plastics. Emphasis is placed on application, limitations as engineering materials, and correlation between properties and chemical structure. Service applications are cited as examples whenever possible. The laboratory exercises consist of the preparation of typical plastics, molding experiments, a study of their properties, and identification tests.

Text: Kinney: Engineering Properties and Applications of Plastics.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-531(A) Physical Chemistry (for Metallurgy Students) 2-0

A continuation of the study of physical chemistry, emphasizing aspects of importance in metallurgy. Chemical equilibria in smelting and refining processes, in deoxidation and in carburizing; principles of controlled atmospheres; activity and activity coefficients in metal solutions; concentration gradients and diffusion effects.

Prerequisites: Physical chemistry and Mt-202(C).

CE-541(A) Reaction Motors 2-2

A course covering the classification of reaction motors, basic mechanics, nozzle theory, propellent performance calculations, liquid and solid propellent motors, rocket testing, ramjet, pulse jet, military applications. Laboratory period is devoted to working problems.

Text: Sutton: Rocket Propulsion Elements.

Prerequisites: Ch-101(C) or equivalent and one term of thermodynamics.

Ch-551(A) Radiochemistry 2-4

Discussions on important aspects of radioactivity from standpoint of the chemical transformations which accompany it and which it may induce; techniques for measurement and study of ionizing radiation; methods of separation of unstable nuclides, identification and assay.

Text: Williams: Principles of Nuclear Chemistry.

Prerequisite: Physical Chemistry.

Ch-552(A) Radiochemistry 3-4

A discussion of chemical properties and behaviors of unstable elements. Topics considered are the formation and decay schemes of the more important unstable nuclides, methods of isolation and purification and analysis of mixtures; exchange reactions; reactions that take place in consequence of nuclear reactions.

Text: To be assigned.

Prerequisite: Ch-551(A).

CE-553(A) Nuclear Chemical Technology 4-3

Applications of chemistry and chemical engineering to the processing of materials, products and wastes associated with nuclear reactors including the following topics: chemistry of uranium, plutonium and fission products, technology of nuclear fuel production, separation of products of nuclear reactors, radioactive waste disposal.

Texts: Glasstone: Principles of Nuclear Reactor Engineering; Bruce et al; Progress in Nuclear Energy III, Process Chemistry; Chemical Engineering Progress Symposium Series on Nuclear Engineering Parts I—III.

Prerequisites: Ch-121(B) and Ch-561(A) or equivalent.

Ch-554(A) Chemistry of Nuclear Fuels 2-2

Basic chemistry of the actinide elements, particularly uranium, plutonium, and thorium, related to their isolation and separation in reprocessed fuels. Discussion of oxidation states and chemical behavior including complex formation, solubilities and resin exchange phenomena. Principle products of fission and their separation from fuel elements.

Text: None.

Prerequisite: Physical Chemistry.

Ch-561(A) Physical Chemistry 3-2

A course in physical chemistry for students who are non-chemistry majors. Thermodynamics, thermochemistry, gases, liquids, solutions, chemical equilibrium and chemical kinetics. Numerical problems on gas mixtures, combustion, equilibria in combustion products and flame temperatures are emphasized. Related laboratory experiments are included.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: CE-111(A) or Ch-121(B).

Ch-571(A) Explosives 3-2

Modes of behavior and principles of use of explosive substances are related to their chemical and physical properties; underlying principles of explosives testing and evaluation; theory of detonation; propagation of flame front in propellants. Trends in new explosives investigation, selection, and development are surveyed. Laboratory work involves related parameters such as brisance, power, sensitivity, nitrogen content, heats of explosion and combustion. Independent exploratory work is encouraged.

Prerequisites: One term each of Thermodynamics and Physical Chemistry.

Ch-581(A) Chemistry of Special Fuels 2-2

A brief survey of the organic and physical chemistry necessary for an appreciation of the problems associated with special fuels. The nature of conventional fuels and of high-energy fuels, their limitations, and possible future developments; methods of reaction rate control; etc.

Prerequisite: Physical Chemistry.

CE-591(A) Blast and Shock Effects 3-0

Nature of explosions, propagation of shock waves, scaling laws for damage from explosions, thermal radiation and incendiary effects; ionizing radiation effects; principles of protection of personnel against damage.

Text: Hirschfelder and Associates: The Effects of Atomic Weapons.

Prerequisites: Physical Chemistry, and Thermodynamics.

CE-611(C)_Thermodynamics 3-2

Study of the fundamentals of thermodynamics, the concept of energy and its classification and transformation, concept of entropy, the first and second laws and their application, thermodynamic properties of substances, ideal gases, thermochemistry. The laboratory period is devoted to problem working.

Text: Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics.

Prerequisite: Ch-101(C).

CE-612(C) Thermodynamics 3-2

A continuation of CE-611, covering the application of thermodynamic principles to processes involving non-ideal gases, complex systems in chemical equilibrium, and the flow of compressible fluids. The laboratory period is devoted to problem working.

Texts: Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics; Smith: Introduction to Chemical Engineering Thermodynamics.

Prerequisite: CE-611(C).

CE-613(A)_Chemical Engineering Thermodynamics 3-2

Designed for non-chemical majors, the course extends previous studies in mechanical engineering thermodynamics to include the thermodynamic analysis and solution of chemical engineering problems. Emphasizing applications of principles by solution of problems, the subject matter includes specialized treatment of the thermal and thermodynamic properties of materials; thermochemistry; equilibrium and the phase rule; phase relations; chemical equilibria and energy relations, particularly at higher temperatures and pressures. Special attention is devoted to the thermodynamics of combustion processes.

Texts: Smith: Introduction to Chemical Engineering Thermodynamics; Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics.

Prerequisites: One term of Physical Chemistry and one term of Thermodynamics.

CE-631(A)_Chemical Engineering Thermodynamics 3-2

An extension of CE-711(C) to include such thermodynamic analyses as are fundamental and requisite to the solution of many ordnance problems; preparation for subsequent study of reaction motors and interior ballistics.

In addition to treatment of the First and Second Laws of Thermodynamics, the subject matter includes thermodynamic properties of matter, compression and expansion processes, phase equilibria, criteria of equilibrium, fugacity, chemical reaction equilibria.

Texts: Smith: Introduction to Chemical Thermodynamics; Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics; Keenan and Keyes: Thermodynamic Properties of Steam; Keenan and Kaye: Gas Tables.

Prerequisite: CE-711(C) or CE-701(C).

CE-701(C) Chemical Engineering Calculations 3-2

Recognition and solution of engineering problems involving mass and energy relationships in chemical and physical-chemical reactions. Problems are chosen from engineering practice whenever possible and emphasize such applications as: reacting materials, particularly at high temperatures; gaseous and liquid-vapor equilibria; combustion of fuels; production and utilization of basic chemicals.

Texts: Hougen and Watson: Chemical Process Principles, Part I; Lewis and Radasch: Industrial Stoichiometry; Perry: Chemical Engineers' Handbook.

Prerequisite: Ch-101(C), or Ch-121(B)

CE-711(C) Chemical Engineering Calculations 3-2

An introductory course in chemical engineering, with part of the numerical problems selected from ordnance applications; material and energy balances in various unit operations and in typical chemical reactions, processes and plants; principles of thermochemistry; composition of equilibrium mixtures.

Texts: Hougen and Watson: Chemical Process Principles, Part I; Robinson: Thermodynamics of Firearms.

Prerequisite: Ch-101(C).

CE-721(B) Unit Operations 3-2

An introduction to the study of the unit operations of chemical engineering. Selection of and primary emphasis on particular unit operations will be made on the basis of current student specialties; e.g., Petroleum Engineering. Among the unit operations, treatment will be given to flow of fluids, filtration, agitation, mixing, sedimentation, heat transmission, evaporation, and drying. Both theoretical and applied material will be illustrated by quantitative examples.

Texts: Brown and Associates: Unit Operations; Perry: Chemical Engineers' Handbook.

Prerequisites: CE-701(C) and Ch-411(C).

CE-722(A) Unit Operations 3-2

A continuation of CE-721: Size reduction, sizing, crystallization, gas absorption, liquid-liquid extraction, batch and continuous distillation; fractionation columns.

Texts: Brown and Associates: Unit Operations; Perry: Chemical Engineers' Handbook.

Prerequisite: CE-721(B).

CE-731(A) Petroleum Refinery Engineering 3-0

A study of the engineering, chemical, and economic aspects of modern petroleum refinery practice. This course includes the following topics: evaluation of crude oils, process studies such as catalytic cracking, aviation gasoline manufacture, Fischer-Tropsch synthesis, chemical refining of lubricating oils, theory, design, cost, and operation of refinery process equipment, factors determining method of treatment, plant design, applied reaction kinetics, and catalysis and applied thermodynamics of hydrocarbons.

Texts: Nelson: Petroleum Refinery Engineering; Sachanen: Conversion of Petroleum; Huntington: Natural Gas and Natural Gasoline; Selected readings in current technical journals.

Prerequisite: CE-722(A).

CE-732(A) Petroleum Refinery Engineering 3-2

A continuation of CE-731.

Texts: Nelson: Petroleum Refinery Engineering; Sachanen: Conversion of Petroleum; Huntington: Natural Gas and Natural Gasoline; Selected readings in current technical journals.

Prerequisite: CE-731(A).

Ch-800(A) Chemistry Seminar

This course involves library investigations of assigned topics, and reports on articles in the current technical journals.

COMMAND COMMUNICATIONS

Co Courses

Communication Principles and Procedures ----------Co-101(C)
Typing and Operating Procedures ------Co-101a(C)
Communication Principles and Procedures ----------Co-102(C)
Communications-Electronics Security ----Co-111(C)
Communications-Electronics Security ----Co-112(C)
Cryptographic Methods and Procedures --Co-113(C)
Cryptographic Methods and Procedures --Co-114(C)
Commercial Communications ----------Co-121(C)
Communications Planning ----------Co-123(C)
Communications Planning ----------Co-124(C)
Naval Warfare Tactics and Procedures ---Co-131(C)
Naval Warfare Tactics and Procedures ---Co-132(C)
Naval Warfare Tactics and Procedures ---Co-133(C)
Naval Warfare Tactics and Procedures ---Co-134(C)
Public Speaking ----------Co-141(C)
Public Speaking ----------Co-142(C)
Communications Seminar ----------Co-154(C)
Naval Fiscal Management ----------Co-162(C)
Administration and Management --------Co-164(C)

Co-101(C) Communication Principles and Procedures 3-2

An introduction to naval communications, with study of the basic communication publications.

Text: Classified official publications.

Prerequisite: None.

Co-101a(C) Typing and Operating Procedures 0-2

A development of the students' ability to touch type to assist them in future courses. Those students who are proficient in typing apply the principles learned in Co-101(C) to actual practice in various communications procedures.

Text: Classified official publications.

Prerequisite: None.

Co-102(C) Communication Principles and Procedures 2-2

A continuation of Co-101(C).

Text: Classified official publications.

Prerequisite: Co-101(C).

Co-111(C) Communications-Electronics Security 2-0

A study of the various aspects of communications-electronics security.

Text: Classified official publications.

Prerequisite: None.

Co-112(C) Communications-Electronics Security 1-1

A continuation of Co-111(C).

Text: Classified official publications.

Prerequisite: Co-111(C).

Co-113(C) Cryptographic Methods and Procedures 0-3

A study of the basic principles of cryptography and the detailed procedures employed in the use of the various cryptosystems.

Text: Classified official publications.

Prerequisite: Co-112(C).

Co-114(C) Cryptographic Methods and Procedures 0-3

A continuation of Co-113(C).

Text: Classified official publications.

Prerequisite: Co-113(C).

Co-121(C) Commercial Communications 2-0

A study of commercial traffic regulations, including principles, policies, format and accounting procedures.

Text: Classified official publications.

Prerequisite: None.

Co-123(C) Communications Planning 3-2

A study of the functions and facilities of naval communications, including details of tactical communications and preparation of communications-electronics plans and orders.

Text: Classified official publications.

Prerequisite: None.

Co-124(C) Communications Planning 3-2

A continuation of Co-123(C).

Text: Classified official publications.

Prerequisite: Co-123(C).

Co-131(C) Naval Warfare Tactics and Procedures 4-3

A course designed to provide a working knowledge of naval tactics and procedures, and the fundamental principles underlying the successful prosecution of naval warfare.

Text: Classified official publications.

Prerequisite: None.

Co-132(C) Naval Warfare Tactics and Procedures 4-3

A continuation of Co-131(C).

Text: Classified official publications.

Prerequisite: Co-131(C.

Co-133(C) Naval Warfare Tactics and Procedures 4-3

A continuation of Co-132(C).

Text: Classified official publications.

Prerequisite: Co-132(C).

Co-134(C) Naval Warfare Tactics and Procedures 4-3

A continuation of Co-133(C).

Text: Classified official publications.

Prerequisite: Co-133(C).

Co-141(C) Public Speaking 0-1

Instruction and practice in the effective delivery of speech.

Text: None.

Prerequisite: None.

Co-142(C) Public Speaking 0-1

A continuation of Co-141(C).

Text: None.

Prerequisite: None.

Co-154(C) Communications Seminar 0-2

A study of the various military communication organizations and their relation to naval communications. A portion of the course is devoted to seminar presentation of papers prepared by each student on a communication subject, and to lectures by representatives of military communication organizations.

Text: Classified official publications.

Prerequisite: None.

Co-162(C) Naval Fiscal Management 2-0

A series of lectures covering the principles of business administration applicable to naval command, administration of allotments, application of fiscal and material controls, conservation and economy measures.

Text: Classified official publications.

Prerequisite: None.

Co-164(C) Administration and Management 3-0

A study of the organization of naval staffs; a study of the principles of effective written communication; a study of the Navy Postal System.

Text: Classified official publications.

Prerequisite: None.

CRYSTALLOGRAPHY

Cr Courses

Crystallography and X-Ray Techniques___Cr-271(B)
Crystallography and Mineralogy_____Cr-301(B)
Crystallography and Mineralogy _____Cr-311(B)

Cr-271(B) Crystallography and X-Ray Techniques 3-2

The essential concepts of crystallography, including: symmetry, point groups, plane lattices, space lattices, space groups, coordinate systems, indices, crystal classes, crystal systems, common forms and combinations in the various systems, the stereographic projection, modern x-ray diffraction and radiographic apparatus and techniques, the theory of x-ray diffraction, powder methods, single crystal and moving film methods, high temperature diffraction techniques, back reflection and transmitted beam methods. The laboratory work includes a study of crystal models for symmetry, forms, and combinations; the construction of stereographic projections; and actual practice in making and interpreting of x-ray diffraction photographs.

Texts: Buerger: Elementary Crystallography; Barrett: Structure of Metals.

Prerequisite: Ch-101(C).

Cr-301(B) Crystallography and Mineralogy 3-4

Designed primarily for the student who will continue with courses in mineralogy, geology, and petrology. The student is introduced to the fundamental concepts of crystallography, including: symmetry, point groups, plane lattices, space lattices, space groups, coordinate systems, indices, crystal classes, crystal systems, common form and combinations in the various systems and classes, the stereographic projection, and the theory of x-ray diffraction and the application of x-ray powder methods as applied to identification of minerals. The laboratory work includes a study of crystal models for symmetry forms, and combinations; the practical application and construction of stereographic projections; determination of minerals by x-ray powder diffraction patterns.

Text: Rogers: Introduction to the Study of Minerals.

Prerequisite: Ch-101(C).

Cr-311(B) Crystallography and Mineralogy 3-2

Subject matter similar to Cr-301, but designed for students who will continue with courses in chemistry.

Text: Rogers: Introduction to the Study of Minerals.

Prerequisite: Ch-101(C).

ELECTRICAL ENGINEERING

EE Courses

Fundamentals of Electrical Engineering ..EE-111(C)
Direct-Current Circuits and Fields .....EE-151(C)
Electrical Circuits and Fields .....EE-171(C)
Circuits and Machines .....EE-231(C)
Alternating-Current Circuits .....EE-241(C)
Alternating-Current Circuits .....EE-251(C)
Alternating-Current Circuits .....EE-271(C)
Alternating-Current Circuits .....EE-272(B)
Electrical Measurements I .....EE-273(C)
Electrical Measurements II .....EE-274(B)
Electrical Machinery .....EE-314(C)
Direct-Current Machinery .....EE-351(C)
Direct-Current Machinery .....EE-371(C)
Transformers and Synchros .....EE-451(C)
Alternating-Current Machinery .....EE-452(C)
Alternating-Current Machinery .....EE-453(C)
Asynchronous Motors .....EE-455(C)
Transformers and Synchros .....EE-461(C)
Special Machinery .....EE-462(B)
Special Machinery .....EE-463(C)
Alternating-Current Machinery .....EE-471(C)
Alternating-Current Machinery .....EE-472(C)
Synchros .....EE-473(B)
Transmission Lines and Filters .....EE-551(B)
Transmission Lines and Filters .....EE-571(B)
Servomechanisms .....EE-611(B)
Transients and Servos .....EE-651(B)
Filters and Transients .....EE-655(B)
Circuit Analysis .....EE-660(A)
Circuit Synthesis .....EE-661(A)
Lines, Filters and Transients .....EE-665(B)
Transients .....EE-671(A)
Servomechanisms .....EE-672(A)
Nonlinear Servomechanisms .....EE-673(A)
Advanced Linear Servo Theory .....EE-674(A)
Sampled Data Servo Systems .....EE-675(A)
Linear and Nonlinear Servo Compensation Theory .....EE-676(A)
Survey of Feedback Control Literature ..EE-677(A)
Electronics .....EE-711(C)
Power Electronics .....EE-731(C)
Electronic Control and Measurement ....EE-745(A)
Electronics .....EE-751(C)
Electronics .....EE-753(C)
Electronic Control and Measurement ....EE-755(A)
Electrical Measurement of Non-Electrical Quantities .....EE-756(A)
Electronics .....EE-771(B)
Electronics .....EE-772(B)
Magnetic Amplifiers .....EE-773(A)
Magnetic Design .....EE-851(B)
Electrical Machine Design .....EE-871(A)
Electrical Machine Design .....EE-872(A)
Electrical Machine Design .....EE-873(A)
Electrical Machine Design .....EE-874(A)
Seminar .....EE-971(A)

EE-111(C) Fundamentals of Electrical Engineering 3-2

Basic concepts of direct-current circuits and static electric and magnetic fields are considered. Electrical units, resistivity, electromotive forces, basic measurements and metering equipment, Kirchhoff's laws, magnetism, typical magnetic circuits and simple electrostatic fields are studied.

Text: Dawes: Electrical Engineering, Vol. I.

Prerequisites: Differential and Integral Calculus and Elementary Physics.

EE-151(C) Direct-Current Circuits and Fields 3-4

Designed to provide a good background in electricity and magnetism, this course covers systems of units, Kirchoff's laws, direct-current measurements, magnetism and magnetic circuits, electrostatics, capacitance and inductance. The emphasis is on fundamental concepts with considerable time spent in working problems.

Text: Corcoran: Basic Electrical Engineering.

Prerequisites: Differential and Integral Calculus and Elementary Physics.

EE-171(C) Electrical Circuits and Fields 3-4

As a foundation in electricity and magnetism for a curriculum majoring in electrical science, the basic laws are studied in detail. Units, Kirchhoff's laws, electrostatic fields, magnetic fields, ferromagnetism, direct-current networks, direct-current measurements, calculation of resistance, capacitance and inductance are covered. Basic laboratory experiments deal with measurements, the proper use of metering equipment and magnetic circuits. Supervised problem work is included.

Text: Corcoran: Basic Electrical Engineering.

Prerequisites: Differential and Integral Calculus and Elementary Physics.

EE-231(C) Circuits and Machines 3-2

General principles of DC machines, their control and application. The qualitative characteristics of the various machines are developed from basic principles, then a study of the theory of alternating currents is begun. Experiments are performed to demonstrate the general machine characteristics and the use of control devices.

Text: Dawes: Electrical Engineering, Vols. I and II.

Prerequisite: EE-111(C).

EE-241(C) Alternating-Current Circuits 3-2

For those curricula that do not require an extensive coverage. Consists of an elementary treatment of single-phase series and parallel circuits, resonance, vector representation and vector algebra, the most commonly used network theorems, non-sinusoidal wave analysis, coupled circuits, and balanced polyphase circuits. Laboratory and problem work illustrate the basic theory.

Text: Kerchner and Corcoran: Alternating Current Circuits.

Prerequisite: EE-151(C).

EE-251(C) Alternating-Current Circuits 3-4

This course presents the essentials of alternating-current circuits. Single-phase circuits, resonance, vector representation and complex numbers, basic metering, coupled circuits, and balanced polyphase circuits are treated. The elements of non-sinusoidal wave analysis are included. Laboratory experiments cover series and parallel resonance, single-phase and polyphase metering and elementary bridge measurements. Time is allotted for supervised problem work.

Text: Kerchner and Corcoran: Alternating Current Circuits.

Prerequisite: EE-151(C).

EE-271(C) Alternating-Current Circuits 3-2

The basic theory of the alternating-current circuit for those curricula that require an extensive coverage. Single-phase series and parallel circuits, resonance, vector algebra and vector representation of electrical magnitudes, network theorems, non-sinusoidal wave analysis, balanced polyphase circuits and power measurements in polyphase circuits. Problems and laboratory work illustrate the basic theory.

Text: Kerchner and Corcoran: Alternating Current Circuits, 3rd Edition.

Prerequisite: EE-171(C).

EE-272(B) Alternating-Current Circuits 2-2

A continuation of EE-271. Unbalanced polyphase circuits, instruments and measurements, coupled circuits, bridge theory and symmetrical components. Problems and laboratory work illustrate the basic principles.

Text: Kerchner and Corcoran: Alternating Current Circuits, 3rd Edition.

Prerequisite: EE-271(C).

EE-273(C) Electrical Measurements I 2-3

An introduction to the measurement of the fundamental quantities: current, voltage, capacitance, inductance, and the magnetic properties of materials. Direct-current bridges, the measurement of high resistance, characteristics of direct-current galvanometers, potentiometer principles, commercial potentiometer types, direct-current indicating instruments.

Text: Stout: Basic Electrical Measurements.

Prerequisite: EE-272(C).

EE-274(B) Electrical Measurements II 2-3

A continuation of EE-273(C). Alternating-current bridge circuits, components, and accessories. Measurement of the properties of dielectrics.

Text: Stout: Basic Electrical Measurements.

Prerequisite: EE-273(C).

EE-314(C) Electrical Machinery 3-4

The fundamentals of representative direct-current and alternating-current machines are studied in classroom and supplemented with laboratory experiments. The theory, practical construction, types of windings and the performance of direct-current generators and motors, alternators, transformers, synchronous motors, induction motors, and single-phase motors are briefly covered.

Text: Dawes: Electrical Engineering, Vols. I and II.

Prerequisites: Es-111(C) and Es-112(C).

EE-351(C) Direct-Current Machinery 2-2

Fundamentals of direct-current machinery with emphasis upon operating characteristics and applications. The external characteristics are developed from basic relations. Problems and laboratory work supplement that of the classroom.

Text: Dawes: Electrical Engineering, Vol. I.

Prerequisite: EE-151(C) or EE-171(C).

EE-371(C) Direct-Current Machinery 3-2

A thorough presentation of the theory and performance of direct-current machines and control devices. Armature windings, armature reaction and commutation are fully covered. The operating characteristics of generators and motors are developed from basic relations so as to provide a foundation for subsequent work in design. Problems are assigned to illustrate the application of the theory. Laboratory work supplements the work of the classroom.

Text: Langsdorf: Principles of Direct-Current Machines.

Prerequisite: EE-171(C).

EE-451(C) Transformers and Synchros 2-2

The theory, construction and performance of single-phase transformers and polyphase transformer connections are covered in the first part of the course. Approximately the latter half of the term is given to the study of synchros, their theory, construction and performance under normal and abnormal conditions. Laboratory experiments parallel the classroom study.

Texts: Hehre and Harness: Electrical Circuits and Machinery, Vol. II; Ordnance Pamphlet 1303: Synchros.

Prerequisite: EE-251(C).

EE-452(C) Alternating-Current Machinery 3-4

A continuation of EE-451(C). It completes a general presentation of AC machinery for those curricula that do not require an extensive treatment. Alternators, synchronous motors, polyphase and single-phase induction motors are presented. A brief survey of induction generators, induction regulators and the commutator type AC motor is included. Laboratory and problem work illustrate the basic theory.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II.

Prerequisite: EE-451(C).

EE-453(C) Alternating-Current Machinery 3-4

The basic principles, constructional features and performance characteristics of single and polyphase transformers. Polyphase transformer connections. Special transformers and the induction regulator. Theory and operational characteristics of single and polyphase induction motors, alternating-current generators and synchronous motors. Basic principles and performance characteristics of synchro generators, motors and control transformers under normal operating conditions. Laboratory and problem work illustrate the basic theory.

Texts: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition; Ordnance Pamphlet 1303.

Prerequisite: EE-251(C).

EE-455(C) Asynchronous Motors 2-2

An elementary presentation of the principles and operating characteristics of the induction motor and of single-phase commutator motors. Emphasis is placed upon the unbalanced operation of the two-phase symmetrical induction motor. Laboratory and problem work supplement the theory.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II.

Prerequisite: EE-451(C).

EE-461(C) Transformers and Synchros 3-2

For those curricula which do not require an extensive coverage of these topics. Single-phase transformer principles, constructional features and operating characteristics. Special transformers. Synchro and induction motor windings. Single-phase and polyphase synchro constructional features. Mathematical analysis of the torque, current and voltage characteristics of synchros operating under normal and fault conditions. Synchros in control circuits. Laboratory and problem work illustrate the basic principles.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II; Ordnance Pamphlet 1303.

Prerequisite: EE-241(C) or EE-251(C).

EE-462(B) Special Machinery 4-2

Basic principles and operating characteristics of single-phase and polyphase induction motors and single-phase commutator motors. Operation of two-phase induction motors with unbalanced voltages and variable phase angles. Theory and operating characteristics of amplidyne and rototrol generators. Operation of direct-current motors on variable voltage. Calculation of the transfer function for motors and generators. Laboratory and problem work illustrate the basic principles.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II.

Prerequisite: EE-461(C).

EE-463(C) Special Machinery 3-2

The theory and performance of single phase, iron core transformers at power and audio frequencies with particular attention to attenuation and phase shift as affected by leakage inductance and distributed capacitance; synchro control transformer, synchro motor and synchro generator principles under normal operating conditions; polyphase and single phase induction motor principles and operating characteristics in control applications are emphasized. A brief treatment of DC machinery and special machinery theory (amplidyne, etc.) is included to illustrate the signficance of time constants, transfer functions and concepts important in control applications. Laboratory and problem work supplement the theory.

Text: Hehre and Harness; Electrical Circuits and Machinery, Vol. II.

Prerequisite: EE-251(C) .

EE-471(C) Alternating-Current Machinery 3-4

For those curricula giving advanced work in electrical engineering. Basic theory and operating characteristics of single-phase and polyphase transformers, special transformers, polyphase and single-phase induction motors, induction generators and commutator type alternating-current motors. Motor and generator armature windings, voltage and mmf waves. Laboratory and problem work illustrate the basic theory.

Text: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition.

Prerequisite: EE-272(B).

EE-472(C) Alternating-Current Machinery 3-4

A continuation of EE-471(C). Alternator and synchronous motor theory and operating characteristics based on cylindrical rotor and two-reaction theories. Armature windings. Voltage, current and mmf waves. Load saturation characteristics, regulation and losses. Frequency changers. Parallel operation of synchronous machines. Synchro principles and mathematical analysis of operating characteristics for normal and fault conditions. Laboratory and problem work illustrate the basic principles.

Text: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition.

Prerequisite: EE-471(C).

EE-473(B) Synchros 2-2

Basic theory and mathematical analysis of single-phase and polyphase synchros. Voltage, current and torque relations under normal and fault conditions. Equivalent circuits and vector diagrams, control circuits using synchros. Laboratory and problem work supplement the study of basic principles.

Text: None.

Prerequisite: EE-251(C) or EE-271(C).

EE-551(B) Transmission Lines and Filters 3-2

An intermediate level course for those curricula which do not require the more thorough treatment given in EE-571(B). Transmission line parameters, general transmission line equations for distributed parameters, infinite line, open and short circuited lines, loading, reflection and equivalent circuits. Impedance transformation and impedance matching with stubs and networks. Constant K, M-derived and composite filters. Problems and laboratory work illustrate the basic theory.

Text: Ware and Reed: Communication Circuits.

Prerequisite: EE-251(C).

EE-571(B) Transmission Lines and Filters 3-4

A more thorough coverage of transmission line and filter theory and more emphasis on transmission at power frequencies than given in EE-551(B). Transmission line parameters, general transmission line equations, transmission line vector diagrams and charts. Losses, efficiency and regulation. Loading, open-circuited lines, short-circuited lines and reflection. Equivalent circuits. Impedance transformation, impedance matching with networks and stubs. Transient voltages and currents on lines. Constant K, M-derived and composite filters for low pass, high pass, band pass and band elimination. Problems and laboratory work illustrate the basic principles.

Texts: Woodruff: Electric Power Transmission and Distribution; Ware and Reed: Communication Circuits.

Prerequisite: EE-271(C).

EE-611(B) Servomechanisms 3-4

This course presents the essential basic principles of servomechanisms. The topics covered are the amplidyne, the elements of electrical transients, the synchro, and an introduction to servomechanism devices. Problems and laboratory work supplement the classroom theory.

Texts: Kurtz and Corcoran: Introduction to Electric Transients; Lauer, Lesnick and Matson: Servomechanism Fundamentals.

Prerequisite: EE-314(C).

EE-651(B) Transients and Servomechanisms 3-4

Basic principles of electric transients and servomechanisms. DC and AC transients in series, parallel, series-parallel and coupled circuits. The solution of the differential equations by classical and Laplace operational methods. Servomechanisms with viscous damping and differential and integral control. Problems and laboratory experiments illustrate the theory.

Texts: Gardner and Barnes: Transients in Linear Systems; Lauer, Lesnick and Matson: Servomechanisms Fundamentals.

Prerequisites: EE-451(C) and EE-711(C) or EE-751(C).

EE-655(B) Filters and Transients 3-2

Basic principles of filters and electrical transients. T and Pi section filters and composite filters. DC and AC transients in series, parallel, series-parallel and coupled circuits. The solution of the differential equations by classical methods and Laplace operational methods.

Texts: Kerchner and Corcoran: Alternating Current Circuits; Kurtz and Corcoran: Introduction to Electrical Transients.

Prerequisite: EE-251(C).

EE-660(A) Circuit Analysis 3-2

The study of electric networks utilizing the pole and zero approach. Concepts of sinusoidal steady state response and transient response are unified using this method. The Cauer and Foster forms of reactive networks are studied. Feedback circuits and electronic circuits are investigated. Filter circuits are considered from the image parameter point-of-view.

Text: Van Valkenburg: Network Analysis.

Prerequisite: EE-251(C) or equivalent.

EE-661(A) Circuit Synthesis 3-2

The concepts studied in EE-660(A) are extended to form a foundation for the design of electrical networks.

Texts: Reed: Electric Network Synthesis; Truxal: Control System Synthesis.

Prerequisite: EE-660(A).

EE-665(B) Lines, Filters and Transients 4-2

The basic principles of each subject are presented. The topics covered are: transmission line parameters, infinite lines, open and shorted lines, reflection, matching, stubs, T and Pi sections, constant K and M-derived sections and composite filters; DC and AC transients in series, parallel, series-parallel and coupled circuits for particular boundary conditions using the Laplace transform methods. An introduction to transfer functions and elementary machine transients is included.

Texts: Gardner and Barnes: Transients in Linear Systems; Kurtz and Corcoran: Introduction to Electric Transients; Ware and Reed: Communication Circuits.

Prerequisites: EE-241(C) and Ma-114(A) or equivalent.

EE-671(A) Transients 3-4

The basic theory and practical applications of transient phenomena are treated in detail. Emphasis is on electric circuits and electromechanical system transients. Topics covered are: DC and AC transients in series, parallel, series-parallel, coupled and multiloop circuits; transients in motors, generators, and elementary servo systems; transfer functions, elementary non-linear transients; the analogue computer and its use. The Laplace transform method is used.

Texts: Gardner and Barnes: Transients in Linear Systems; Kurtz and Corcoran: Introduction to Electric Transients.

Prerequisite: EE-251(C) or EE-272(C).

EE-672(A) Servomechanisms 3-3

The mathematical theory of linear feedback-control systems is discussed in detail. Topics are: Basic system equations, time domain and frequency domain relationships, methods for improving performance, damping, differentiation and integration and their relationship to phase concepts, polar and logarithmic plots, design calculations, introduction to the root locus method. Problems and laboratory work illustrate the theory.

Text: Thaler and Brown: Servomechanisms Analysis.

Prerequisites: EE-671(A), EE-452(C) or EE-473(B) and EE-751(C) or equivalent.

EE-673(A) Nonlinear Servomechanisms 3-2

A detailed study of phase plane methods and describing function methods. Application of these methods in the analysis and design of nonlinear servos, with emphasis on relay servos.

Text: None.

Prerequisite: EE-672(A).

EE-674(A) Advanced Linear Servo Theory 3-0

This course includes the following topics: System analysis in the time domain; pole, zero, and root locations, and their interpretation in terms of system performance; root loci and their uses, correlations between the time domain and the frequency domain; methods for computing the transient response from the frequency response; multiple loop servo systems and coupled servo systems, with emphasis on stability criteria.

Text: Truxal: Control System Synthesis.

Prerequisites: EE-671(A) and EE-672(A).

EE-675(A) Sampled Data Servo Systems 3-0

A study of the response of servo systems to discontinuous information. The effect of location of the sampler and of the rate of sampling. Z-transformation theory. Data smoothing and prediction. Application of phase plane techniques.

Texts: Truxal: Control Systems Synthesis; Classroom Notes.

Prerequisites: EE-673(A) and EE-674(A).

EE-676(A) Linear and Nonlinear Servo Compensation Theory 3-0

Extension of normal compensation methods to multiple loop servos. Nonlinear compensation for otherwise linear servos. Linear and nonlinear servos.

Text: None.

Prerequisites: EE-673(A) and EE-674(A).

EE-677(A) Survey of Feedback Control Literature 1-0

An analysis of current developments in feedback control systems, as disclosed by papers in current technical journals. This course is intended only for candidates for the Doctor's Degree.

Text: None.

Prerequisites: EE-671(A) and EE-672(A).

EE-711(C) Electronics 3-2

The elementary theory of the control of electron motion by electric and magnetic fields in vacuum, gaseous conduction phenomena and electron tube characteristics are presented as a basis for the study of electronic circuits. The principles of the amplifier, rectifier and oscillator circuits are presented in their essentials. Some consideration is given to the special tubes encountered in electronic devices. Laboratory work serves to integrate the principles presented in the classroom with practical applications and circuits.

Text: Fink: Engineering Electronics.

Prerequisite: EE-251(C).

EE-731(C) Power Electronics 3-2

The theory and application of various types of electron tubes is covered with particular emphasis on the thyratron. The principles of electronics circuitry as applied to the control of power in motors, generators and selsyn instruments constitute the general theme of the course. Application in naval devices is stressed. The laboratory work consists of experiments to demonstrate the theory.

Text: Ryder: Electronic Engineering Principles.

Prerequisite: EE-231(C).

EE-745(A) Electronic Control and Measurement 3-3

This course presents the principles and practice of electronic control and measurement as found in research laboratories and in industry. It includes the theory of such basic circuits as vacuum tube voltmeters, direct coupled amplifiers, oscillators, timing circuits and frequency sensitive circuits with particular attention to their application in the measurement and control of current, voltage, frequency, speed, pressure, temperature and illumination. Some time is devoted to the study of data transmission methods by modulation and detection in carrier systems. Applications are studied in the laboratory.

Text: MIT Staff: Applied Electronics.

Prerequisite: EE-751(C).

EE-751(C) Electronics 3-4

A general introduction to the art and science of electronics. Topics treated are: electron ballistics, characteristics of vacuum tubes, gas discharge phenomena, gas tube characteristics, transistor theory and applications. The theory of electronic elements is extended to a study of their application in rectifier, amplifier and oscillator circuits with as thorough a coverage as time will allow. Problems and laboratory work supplement the lectures.

Text: Corcoran and Price: Electronics.

Prerequisite: EE-451(C).

EE-753(C) Electronics 1-2

A continuation of EE-751 with emphasis on application and electronic controls. The lectures include the theory and application of magnetic amplifiers, gas tube control circuits and the principles of feedback in the control and regulation of motors, generators and mechanical devices. Laboratory work is emphasized as supplemental to the theory.

Text: None.

Prerequisite: EE-751(C).

EE-755(A) Electronic Control and Measurement 3-4

The principles and practice of electronic control and measurement as found in research laboratories and in industry. Includes the theory of such basic circuits as vacuum tube voltmeters, direct coupled amplifiers, oscillators, timing circuits and frequency sensitive circuits with particular attention to their application in the measurement and control of current, voltage, frequency, speed, pressure, temperature and illumination. Some time is devoted to the study of data transmission methods by modulation and detection in carrier systems. Applications are studied in the laboratory.

Text: MIT Staff: Applied Electronics.

Prerequisite: EE-751(C).

EE-756(A) Electrical Measurement of Non-Electrical Quantities 3-3

The measurement of pressure, speed acceleration, vibration strain, heat, sound, light, time displacement, and other non-electrical quantities by electrical means. Consideration of special problems of measurement encountered in development of missiles and missile guidance systems.

Texts: Kinnard: Applied Electrical Measurements; Grey: Applied Electronics, Second Edition.

Prerequisites: EE-751 or equivalent.

EE-771(B) Electronics 3-2

The theory of electron tubes and circuits for those curricula requiring a more advanced treatment. The theory of electron motion in electric and magnetic fields, vacuum and gas tube characteristics and the principles of such tubes as the ignitron, glow tube, cathode-ray tube and phototube. Circuit theory of rectifiers, detectors, amplifiers and oscillators is covered, with particular attention to industrial and naval power and control applications. Laboratory experiments and problems supplement the basic theory.

Text: MIT Staff: Applied Electronics.

Prerequisite: EE-272(C).

EE-772(B) Electronics 3-2

A continuation of EE-771(B). The more complicated electronic circuits encountered in practice with particular attention to the integration of various components in accordance with the basic theory of feedback and stabilization.

Text: MIT Staff: Applied Electronics.

Prerequisite: EE-771(B).

EE-773(A) Magnetic Amplifiers 2-3

Basic principles of magnetic amplifiers and magnetic amplifier circuits, including feedback and biasing. Emphasis placed on circuits useful in industrial control and military applications.

Text: W. A. Geyger: Magnetic Amplifier Circuits.

Prerequisite: EE-251(C).

EE-851(B) Magnetic Design 4-0

Selected topics in electromagnetic design principles to satisfy the requirements of a particular curriculum. Typical topics are synchros, transformers, relays, magnetic amplifiers, solenoids, and instruments.

Text: None.

Prerequisites: EE-111 and EE-251.

EE-871(A) Electrical Machine Design 4-0

A quantitative analysis of machine characteristics using the design approach. Serves to develop an appreciation for the limitations and possibilities in electrical machine construction especially for naval applications, and the ability to evaluate properly the merits of present designs. In particular, this course consists of the quantitative study and design of a transformer to meet certain specifications. Later, the analysis of the DC machine is begun.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-472(C).

EE-872(A) Electrical Machine Design 4-0

A continuation of EE-871(A). The completion of the quantitative analysis and design of a DC machine and the beginning of a similar analysis of the synchronous machine.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-871(A).

EE-873(A) Electrical Machine Design 4-0

A continuation of EE-872(A). The completion of the quantitative analysis and design of a synchronous machine and a similar analysis and design of the induction machine.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-872(A).

EE-874(A) Electrical Machine Design 4-0

A continuation of EE-873(A). The design of the induction machine is analyzed quantitatively and its operating characteristics, both as a motor and as an induction generator, are determined.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-873(A).

EE-971(A) Seminar 1-0

In the seminar sessions, papers on research and developments in the field of electrical science are presented to the more advanced group of students. Some appreciation for research methods is developed. In these sessions papers treating of student research in progress and matters of major importance in electrical engineering are delivered by the faculty and by the students pursuing an advanced engineering curriculum.

Text: None.

Prerequisite: A background of advanced work in electrical engineering.

ENGINEERING ELECTRONICS

Es Courses

Fundamentals of Electric Circuits and Circuit Elements I ---------- Es-111(C)
Fundamentals of Electric Circuits and Circuit Elements II ---------- Es-112(C)
Circuit Analysis and Measurements I ---- Es-113(C)
Circuit Analysis and Measurements II ---- Es-114(C)
Transient Circuit Theory ---------- Es-116(C)
Advanced Circuit Theory I ---------- Es-121(B)
Advanced Circuit Theory II ---------- Es-122(A)
Pulse Techniques ---------- Es-123(B)
Radio Frequency Measurements ---------- Es-124(C)
Electronic Computers ---------- Es-125(B)
Radio Frequency Measurements and Micro-wave Techniques ---------- Es-126(C)
Pulse Forming Circuits ---------- Es-127(B)
Information Theory ---------- Es-128(A)
Communication Theory ---------- Es-129(B)
Introduction to Computers ---------- Es-136(A)
Electronic Instrumentation I ---------- Es-161(A)
Electronic Instrumentation II ---------- Es-162(A)
Electron Tubes and Circuits I ---------- Es-212(C)
Electron Tubes and Circuits II ---------- Es-213(C)
Electron Tubes and Circuits III ---------- Es-214(C)
Transistor Electronics ---------- Es-221(A)
Transistor Electronics ---------- Es-222(B)
Electron Tubes ---------- Es-225(B)
Microwave Tubes and Techniques ---------- Es-226(A)
Ultra-High Frequency Techniques ---------- Es-227(B)
Electron Tubes and Circuits I ---------- Es-261(C)
Electron Tubes and Circuits II ---------- Es-262(C)
Electron Tubes and Ultra-High Frequency Techniques ---------- Es-267(A)
Electronics I ---------- Es-271(C)
Electronics II ---------- Es-272(C)
Electronics III ---------- Es-273(C)
Communication Systems I ---------- Es-321(B)
Missile Guidance Systems ---------- Es-323(B)
Transmitters and Receivers ---------- Es-326(C)
Electronic Systems ---------- Es-327(B)
Communication Systems II ---------- Es-332(B)
Communication Systems III ---------- Es-333(B)
Communication Systems IV ---------- Es-334(B)
Electronic Systems ---------- Es-335(B)
Radio Telemetry and Simulation ---------- Es-341(C)
Pulse Techniques ---------- Es-421(B)
Radar Systems I ---------- Es-422(B)
Radar Systems II ---------- Es-423(B)
Radar System Engineering I ---------- Es-431(B)
Radar System Engineering II ---------- Es-432(B)
Radar Data Processing and Computer-Controlled Systems ---------- Es-433(B)
Introduction to Radar ---------- Es-446(C)
Pulse Techniques ---------- Es-447(C)
Introduction to Radar (Airborne) ---------- Es-456(C)
Pulse Techniques ---------- Es-461(A)
Countermeasures ---------- Es-536(B)
Sonar Systems Engineering Design and Developments ---------- Es-537(B)
Introduction to Electromagnetics ---------- Es-615(C)
Electromagnetics I ---------- Es-621(C)
Electromagnetics II ---------- Es-622(B)
Electromagnetics III ---------- Es-623(A)
Guided Waves and Resonators ---------- Es-626(C)
Antennas, Transmission Lines ---------- Es-726(B)
Antennas and Feed Systems ---------- Es-727(B)
Systems Lectures I ---------- Es-821(C)
Systems Lectures II ---------- Es-822(C)
Systems Seminar ---------- Es-823(C)
Project Seminar ---------- Es-836(A)

Es-111(C) Fundamentals of Electrical Circuits and Circuit Elements I 4-4

Basic concepts of circuits and electromagnetic fields. Emphasis upon the setting up and solution of network equations. Principal topics are: Electric field, potential, properties of dielectrics, current and resistance, d-c circuits, magnetic field, magnetic field of a current and of a moving charge, induced electromotive force, magnetic properties of matter, inductance and capacitance, alternating current and voltage, vector representation, complex quantities, elementary circuit concepts, loop and nodal method.

Texts: Sears: Electricity and Magnetism; Tang: Alternating-Current Circuits; Varner: The 14 Systems of Units.

Prerequisite: Mathematics through the calculus.

Es-112(C) Fundamentals of Electric Circuits and Circuit Elements II 4-3

A continuation of Es-111(C). An introduction to alternating current circuit theory. Principal topics are: series circuits, series resonance, parallel circuits, parallel resonance, network theorems, coupled circuits, equivalent coupled circuits, impedance transformation, non-sinusoidal waves, synthesis and Fourier analysis, d-c transients, filter principles.

Texts: Tang: Alternating-Current circuits; Everitt: Communication Engineering; Varner: The 14 Systems of Units.

Prerequisite: Es-111(C).

Es-113(C) Circuit Analysis and Measurements I 3-3

An introduction to the principles and techniques of elementary measurements at audio and radio frequencies. The principal topics are: measurement of AC current and voltage with particular reference to the response to complex wave forms, principles and characteristics of vacuum tube voltmeters, measurement of frequency, measurement of impedance by bridges and Q-meters. An introduction to transmission lines. Definition of terms, line parameters and transmission units.

Text: Terman and Pettit: Electronic Measurements.

Prerequisite: Es-112(C).

Es-114(C) Circuit Analysis and Measurements II 3-0

The infinite line. Properties of open wire and cables; loading. Reflections and the solution of the general line. Derivation and use of circle diagrams. Use of lines and stubs as transformers and matching devices. Use of a line as an impedance measuring device. Qualitative extension of transmission line principles to waveguides and waveguide components. Constant K and m-derived filters.

Text: Everitt: Communication Engineering.

Prerequisite: Es-113(C).

Es-116(C) Transient Circuit Theory 4-2

An introduction to the transient phenomena and circnit properties in electrical networks. Solutions on the loop and nodal basis. The Laplace Transform is presented, without development, to be used as a tool. Lumped constant and distributed constant networks are studied.

Text: Notes by G. R. Giet.

Prerequisites: Es-112(C) and Ma-123(A).

Es-121(B) Advanced Circuit Theory I 4-2

Advanced circuit theory with transient analysis. Principles of differential equations. Basic circuit relations, philosophy of circuit behavior. The Laplace transform treated as a tool and used in circuit analysis and study of circuit properties. Normalized networkers. Harmonic analysis, the Fourier integral and Fourier transform and their use in further study of circuit properties. Development of the Laplace transform from the Fourier transform. Superposition formulae, indicial admittance, impulse functions. Translation, repeated action circuit analysis.

Texts: Notes by Giet; Gardner and Barnes: Transients in Linear Systems; Goldman: Frequency Analysis, Modulation, and Noise.

Prerequisite: Es-114(C).

Es-122(A) Advanced Circuit Theory II 4-2

A continuation of Es-121(B). Two terminal pair networks, matrix algebra applied to the analysis of two terminal pair networks both passive and active, including tube and transistor circuits. Transient analysis of distributed constant circuits, long lines. Introduction to circuit synthesis given a driving point impedance. Foster's Reactance theorem. Synthesis of LC, RL, RC and RLC networks.

Texts: Notes by Giet; Gardner and Barnes: Transients in Linear Systems; Goldman: Frequency Analysis, Modulation, and Noise.

Prerequisite: Es-121(B).

Es-123(B) Pulse Techniques 3-3

Pulse shaping: clipping, clamping, peaking coupling, integrating. Pulse-forming networks and artificial lines. Trigger and multivibrator circuits. Time-base generators. Pulse transformers and blocking oscillators. Transistor switching circuits.

Texts: M.I.T. Radar School Staff: Principles of Radar (Third Edition); Millman and Taub: Pulse and Digital Circuits.

Prerequisites: Es-221(A), Es-213(C) and Es-166(C).

Es-124(C) Radio Frequency Measurements 2-3

This is a continuing study of the problems involved in the measurement of the quantities of interest in electronic circuits. The principles and techniques of measurement of power, impedance and phase over an extended frequency range are studied. The laboratory work will be devoted to drill on the use of these techniques with particular emphasis on the capabilities and limitations of the more commonly used methods and test equipments.

Text: Terman and Pettit: Electronic Measurements.

Prerequisites: Es-113(C) and Es-114(C).

Es-125(B) Computers and Data Processors 3-3

A study of component engineering, logical design and systems engineering considerations in the application of electronic computer methods to data processing and automatic control problems. Principles of organization of digital, analog, and incremental information processing systems. Elements of logical design. Simulation of dynamic systems. Synthesis of computer programs for automatic control. Methods for prediction, smoothing, and tracking. Displays and human engineering.

Texts: Richards: Arithmetic Operations in Digital Computers; Wass: Introduction to Electronic Analog Computers.

Prerequisite: Es-214(C).

Es-126(C) Radio-Frenquency Measurement and Microwave Techniques 2-6

An advanced and extended treatment of the principles and techniques of measurement over the entire frequency band, using lumped, transmission line and waveguide components. The areas considered are those of the measurement of frequency, power, phase, and impedance, by means of lines, bridges and resonance methods. Emphasis in the laboratory is on the development of the ability of the student to analyze a new problem and to plan and implement a method of attack.

Texts: Terman and Pettit: Electronic Measurements; Hartshorn: Radio Frequency Measurements.

Prerequisites: Es-114(C) and Es-225(B).

Es-127(B) Pulse and Digital Techniques 2-3

Study of circuit methods applicable to radar, television, digital computers, pulse communication, data-processing, digital control, and similar systems. Voltage and current time base generators, blocking oscillators, frequency division and multiplication, bit storage elements, AND OR gates, transmission gates, comparators, time modulation, ANDIG and DIGAN converters.

Text: Millman and Taub: Pulse and Digital Circuits.

Prerequisites: Es-121(B), Es-214(C) and Es-221(A).

Es-128(A) Information Theory 4-0

Statistical methods in communications engineering are studied. These include spectra, signal space, correlation techniques, filtering and prediction, information measure, channel capacity and coding.

Texts: Woodward: Probability and Information Theory; Goldman: Information Theory; Lawson and Uhlenbeck: Threshold Signals; Instructor's Notes.

Prerequisites: Es-122(A) and Ma-321(B).

Es-129(B) Communication Theory 4-0

Elementary treatment of selected concepts from probability and statistics. Application of these concepts to an introductory discussion of selected problems arising in electronics engineering. These problems may include: sampling and quality control in electronics manufacturing; noise in electronic components; filtration and detection in the presence of noise; information theory, channel capacity, and coding.

Text: Instructor's Notes.

Prerequisite: Es-116(C).

Es-136(A) Introduction to Computers 3-3

Adaptations of symbolic logic for the analysis of binary information networks using relays, vaccum-tubes, transistors, or magnetic cores. Abstract models for switching networks. Combinational and sequential circuits. Logical design of arithmetic and control elements. Dynamic simulation. Transfer function synthesis. Sampled-data control systems and z-transform theory. Frenquency domain treatment of analog and digital computer programs. Weighting functions for smoothing, prediction and tracking. Digital and Analog techniques for the detection of small signals in noise.

Texts: Instructor's Notes. Selected references from the Periodical Literature.

Prerequisites: Es-127(B) and Es-128(A).

Es-161(A) Electronic Instrumentation I 3-3

The principal topics are: pulse amplifiers, pulse-amplitude analysis circuits, scaling circuits, electronic counter systems, counting-rate meters, coincidence and anti-coincidence circuits.

Text: Elmore and Sands: Electronics; selected references.

Prerequisite: Es-461(A).

Es-162(A) Electronic Instrumentation II 3-3

The principal topics are: special power-supply system considerations, i.e., voltage multipliers, r-f supplies, vibrator circuits, regulation techniques; modulation techniques; multiplex systems; telemetering techniques, radar fundamentals, basic altimetry principles.

Text: Instructor's notes; selected references.

Prerequisite: Es-161(A).

Es-212(C) Electron Tube Circuits I 4-3

The physical principles and characteristics of vacuum and gas tubes is stressed in the first half of this course. This is followed by basic tube circuit theory of amplifier and rectifier circuits.

Texts: Geppert: Basic Electron Tubes; Corcoran and Price: Electronics; Seely: Electron-Tube Circuits.

Prerequisite: Es-111(C).

Es-213(C) Electron Tube Circuits II 4-3

A continuation of Es-212(C). The principal topics are: voltage regulators, grid clamping bias, anode and cathode followers, cathode bias and degeneration, difference amplifier, V.T.V.M., phase inverters, voltage and current servos, grounded grid amplifier, D.C. amplifiers, feedback and operational amplifiers, wide-band amplifiers, tuned voltage and power amplifiers.

Texts: Notes by Bauer; Corcoran and Price: Electronics; Seely: Electron Tubes Circuits; Cruft: Electronic Circuits and Tubes.

Prerequisite: Es-212(C).

Es-214(C) Electron Tube Circuits III 4-3

A continuation of Es-213. The principal topics are: Sine-wave oscillators; amplitude modulation and detection; frequency conversion; frequency-modulation techniques.

Texts: Cruft Electronics Staff: Electronic Circuits and Tubes; Seely: Electron-tube Circuits; Terman: Radio Engineering.

Prerequisite: Es-213(C).

Es-221(A) Transistor Electronics 3-3

The principal topics are: transistors—properties of semi-conductors and P-N junctions; transistors as circuit elements; small and large signal transistor circuit characteristics and analysis.

Texts: RCA Staff: Transistor Electronics; Instructors notes.

Prerequisites: Es-214(C) and Ph-730(A).

Es-222(B) Transistor Electronics 3-3

The principal topics are: electrical characteristics of semi-conductors; P-N junctions and their rectification properties; basic transistor action; transistors as circuit elements; transistor circuit analysis.

Texts: RCA Staff: Transistor Electronics Instructor's notes.

Prerequisites: Es-214(C) and Ph-730(A).

Es-225(B) Electron Tubes 3-3

The tubes treated are those in which operation depends on the motions of electrons under the control of electric and magnetic fields. Some of the tube types studied are picture tubes, beam deflection, storage, and photo tubes. The topic of noise is also included.

Texts: Harman: Fundamentals of Electron Motion; Spangenberg: Vacuum Tubes.

Prerequisite: Es-214(C).

Es-226(A) Microwave Tubes and Techniques 3-3

The principal topics presented are: fundamentals of microwave amplifiers and oscillators, triode and tetrode microwave amplifiers and oscillators, two and three cavity klystrons, reflex klystrons, magnetrons, traveling-wave and double-beam tubes, circuit components, coupling methods, energy transfer, and circuit concepts at microwave frequencies.

Texts: Reich, Ordung, Krause, Skalnik: Microwave Theory and Techniques; Spangenburg: Vacuum Tubes; Harman: Fundamentals of Electron Motion.

Prerequisites: Es-225(B) and Es-623(A).

Es-227(B) Ultra-High Frequency Techniques 3-2

The principles and underlying problems of high-frequency techniques. The principal topics are: limitations of conventional tubes at ultra-high frequencies, transit-time effects, noise problems, electron ballistics, wave guides, cavity resonators, klystrons, magnetrons and traveling-wave tubes. The course emphasizes a descriptive presentation rather than a mathematical one.

Texts: Spangenberg: Vacuum Tubes; Massachusetts Institute of Technology Radar School Staff: Principles or Radar (Third Edition).

Prerequisite: Es-214(C).

Es-261(C) Electron Tubes and Circuits I 3-2

The first term of a two term course in the fundamentals and general applications of electron tubes and circuits, primarily for noncommunication students. The principal topics are: electron emission, characteristics of vacuum tubes, equivalent circuits, rectifiers and filters, class A amplifiers, feedback circuits, gas filled tubes.

Texts: Corcoran and Price: Electronics; Hill: Electronics in Engineering; Schultz, Anderson and Leger: Experiments in Electronics and Communication Engineering; Varner: The 14 Systems of Units.

Prerequisits: Es-111(C) and Es-112(C).

Es-262(C) Electron Tubes and Circuits II 3-2

Continuation of Es-261(C). The principal topics are: class B and C ampliers, semi-conductor diodes and transistors, oscillators, multivibrators and pulse circuits, modulation, detection.

Texts: Estman: Fundamentals of Vacuum Tubes; Corcoran and Price: Electronics; Schulz, Anderson and Leger: Experiments in Electronics and Communication Engineering; Varner: The 14 Systems of Units.

Prerequisite: Es-261(C).

Es-267(A) Electron Tubes and Ultra-High Frequency Techniques 3-2

The principal topics are: electron ballistics, electron optics, cathode-ray tubes, the cyclotron, noise in electron-tube circuits, ultra-high frequency effects, microwave techniques, i.e., cavity resonators, the klystron, the cavity magnetron and the traveling-wave tube.

Texts: Spangenberg: Vacuum Tubes; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-271(C) Electronics I 3-2

This is a series of three courses designed to give the Nuclear Engineering student an appreciation of electronic equipment used in this science. The first course takes the student through the analysis of network circuits and introduces elementary transient concepts.

Texts: Guillemin: Introductory Circuit Theory; Hessler and Carey: Electrical Engineering.

Prerequisite: None.

Es-272(C) Electronics II 3-3

This course includes the common vacuum tube circuits, such as rectifiers, voltage amplifiers, and elementary feedback circuits. Special emphasis is placed on these circuits in regard to transient response, bandwidth, stability, and pulse shaping. Also included is semiconductor diode and transistor theory.

Texts: Hill: Electronics in Engineering; Corcoran and Price: Electronics.

Prerequisite: Es-271(C).

Es-273(C) Electronics III 3-2

This course emphasises systems of vacuum tube circuits used by the nuclear engineer, such as the cathode-ray oscilliscope, scalers, counters, pulse height analyzers, Geiger counters, and other nuclear energy detecting devices such as Radiac. Detection and measurement of nuclear energy by making use of telemetering systems is also included.

Texts: Seely: Electron Tube Circuits; Elmore and Sands: Electronics.

Prerequisite: Es-272(C).

Es-321(B) Communication Systems I 2-0

The first of a series of five courses designed to give the student the opportunity to coordinate his previous theoretical background in the philosophy, requirements, and synthesis of increasingly complex electronic systems. Class discussion is supported by laboratory projects which include tests for the determination of system characteristics and relative capabilities and limitations. The first course concerns itself primarily with the design of radio transmitters for the medium and high frequency range, together with considerations which lead to a successful system, such as reliability, consideration in human engineering, etc.

Texts: Terman: Radio Engineering Handbook; Federal Telephone and Telegraph Corporation: Reference Data for Radio Engineers; Black: Modulation Theory; Navy Equipment Manuals.

Prerequisites: Es-225(B) and Ma-104(A).

Es-323(B) Missile Guidance Systems 3-0

A study of missile guidance systems. The principal topics are: Fundamental problems of missile guidance, prior and present day missile guidance systems, missile guidance servo requirements, launching transients, simulation and computation of the missile guidance system, radio telemetry.

Texts: Locke: Principles of Guided Missile Design; Instructor's Notes.

Prerequisite: Es-327(B).

Es-326(B) Transmitters and Receivers 4-2

A study of audio-bandwidth communications systems. This course concerns itself heavily with the design of radio transmitters and receivers together with a consideration of diversity and scatter propagation techniques, single sideband generation and reception, frequency modulation.

Texts: Navy Instruction Manuals; Current technical literature; Instructor's notes.

Prerequisite: Es-214(C).

Es-327(B) Electronic Systems 3-3

A continuation of Es-326(B). This course concerns itself with specialized electronic techniques. Topics covered are: automatic telegraphy, image systems, pulse modulation systems, time-division multiplexing.

Texts: Navy Instruction Manuals; Current technical literature; Instructor's notes.

Prerequisite: Es-326(B).

Es-332(B)_Communication Systems II 2-3

A study of the considerations involved in the design of communication receivers for range from VLF to UHF. The use of propagation prediction data, and the natural division of services and frequency allocations is also covered.

Texts: Sturley: Radio Receiver Design; Wallman and Valley: Vacuum Tube Amplifiers; Terman: Radio Engineering Handbook; Black: Modulation Theory.

Prerequisite: Es-321(B).

Es-333(B) Communications Systems III 3-3

A continuation of the communications systems sequence directed toward the study of recent and advanced methods of establishing a communication link. Considerable emphasis is placed on the information-theoretic viewpoint and use is made of statistical methods in the comparative evaluation of various techniques. Topics covered are: Statistical properties of fading, diversity and scatter propagation techniques, single-sideband systems, wideband systems, e.g., frequency modulation, pulse modulation, time-division multiplexing.

Texts: Black: Modulation Theory; Goldman: Frequency Analysis, Modulation, and Noise; Instructor's notes.

Prerequisite: Es-332(B).

Es-334(B) Communications Systems IV 2-3

A continuation of Es-333(B). This course considers communication systems involving a variety of presentation techniques. Topics covered are: automatic telegraphy, image systems, e,g., facsimile and television.

Texts: Black: Modulation Theory; Current technical literature; Instructor's notes.

Prerequisite: Es-333(B).

Es-335(B) Electronic System 3-3

Study in this course is directed toward the philosophy, principles, and design of electronic aids to navigation, missile guidance systems and electronic countermeasures. A study of telemetering is included in support of missile guidance systems.

Texts: Navy Instruction Manuals; Instructor's Notes.

Prerequisite: Es-334(B).

Es-341(C) Radio Telemetry and Simulation 3-3

A survey of telemetering and missile guidance methods including consideration of time and frequency division multiplexing, pulse modulation techniques, FM/FM telemetry, transducers, data recording devices, analog and digital computation, simulation of the tactical problem, and classroom and laboratory study of existing telemetering and missile guidance systems.

Text: To be designated.

Prerequisite: Es-423(B).

Es-421(B) Pulse Techniques 2-3

The principles and underlying problems of pulse techniques. Principal topics are: pulse-shaping, switching, clipping differentiating and integrating circuits; sweep-circuit generators; pulse transformers; delay lines; transistors.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: EE-771(B).

Es-422(B) Radar Systems I 3-3

A study of the fundamental principles of radar. The principal topics are: the theory of operation of radar timing circuits, indicators, modulators, transmitters, r-f systems and receivers, the radar range equation.

Texts: Ridenour: Radar System Engineering; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-421(B).

Es-423(B) Radar Systems II 3-6

A continuation of Es-422(B). The course contents include a study of representative search, fire-control and IFF systems, including airborne, with particular attention to design features; a study of current radar developments; related laboratory work on current Navy radar equipment.

Text: Ridenour: Radar System Engineering.

Prerequisite: Es-422(B).

Es-431(B) Radar System Engineering I 3-3

A treatment of the fundamental principles of radar. The principal topics are: the theory of operation and design features of radar timing circuits, indicators, modulators, transmitters, r-f systems and receivers.

Texts: Ridenour: Radar System Engineering; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-127(B).

Es-432(B) Radar System Engineering II 3-6

A continuation of Es-431(B). The course contents include a study of representative search, fire-control and IFF systems, including airborne, with particular attention to design features; a study of current radar developments; related laboratory work on current Navy radar equipment.

Text: Ridenour: Radar System Engineering.

Prerequisite: Es-431(B).

Es-433(B) Radar Data Processing and Computer-Controlled Systems 3-3

A study of advanced applications of computer techniques in systems of importance to the Naval Service. Coding and transmission of radar range data. Reliable digital communication links. Programming of computers for automatic tracking and for generation of weapons control orders. Principles of track-while-scan radar systems. Computer techniques applicable to various types of missile guidance systems.

Texts: Classified Official Publications.

Prerequisites: Es-136(A) and Es-432(B).

Es-446(C) Introduction to Radar 2-2

A study of the radar range equation, i.e., effect of pulse duration, pulse repetition frequency, types of targets, etc.; block diagram studies of current fire-control systems, with emphasis on operational limitations, propagation phenomena, types of presentation, and anti-jam techniques; and laboratory work that emphasizes operational techniques of current fire-control systems.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-447(C) Pulse Techniques 3-0

The basic principles of pulse-shaping circuits, clippers, peakers, gaters, etc., pulse-forming networks and artificial lines. Also, r-f, i-f and video amplifiers are treated from the view point of pulse amplification, distortion tolerances and requirements. The course is directed toward preparing the students for more advanced courses in radar.

Texts: Ridenour: Radar System Engineering; M. I. T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-456(C) Introduction to Radar (Airborne) 2-2

A study of the radar range equation, i.e., effect of pulse duration, pulse repetition frequency, types of targets, etc., block diagram studies of current airborne systems with emphasis on operational limitations, propagation phenomena, types of presentation, and anti-jam techniques and laboratory work on current airborne radar equipment.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-461(A) Pulse Techniques 3-3

The principal topics are: clipping circuits, differentiating and integrating circuits, clamping circuits, pulse-coupling circuits, relaxation oscillators, theory and circuit application of the transistor.

Texts: Spangenberg: Vacuum Tubes; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-267(A).

Es-536(B) Countermeasures 2-3

Principles of radio direction finding; special electronic circuits with particular application to the field of electronic counter-measures; basic principles of electronic counter-measures tactics and operational procedures; passive and active electronic countermeasures equipment.

Texts: Radio Research Laboratory Staff: Very High Frequency Techniques, Vols. I and II; Navy equipment manuals; Instructor's notes.

Prerequisite: None.

Es-537(B) Sonar System Engineering Design and Developments 3-3

Classroom and laboratory study of engineering design problems met in operational and developmental sonar systems.

Texts: Classified Technical Reports; Navy Equipment Instruction Books.

Prerequisite: Ph-423(A).

Es-615(C) Introduction to Electromagnetics 4-0

An elementary study of the fundamental field concepts of electromagnetic theory. This includes a review of vector analysis, and a study of the experimental laws of electromagnetism and their application to electrostatics, electric currents, magnetostatics and electromagnetic induction, Maxwell's equations are formulated and applied to a study of plane waves, Poynting's vector, skin effect phenomena, refraction and reflection of plane waves, elliptical polarization, electromagnetic potentials and dipole radiation, and an introduction to antennas and radio wave propagation.

Text: Skilling: Fundamentals of Electric Waves (Second Edition).

Prerequisites: Es-114(C) and Ma-122(B).

Es-621(C) Electromagnetics I 4-0

An introduction to the concepts utilized in electromagnetic theory. The material covered includes vector analysis, field theorems, the electrostatic field, dielectric materials, electric current, the magnetic field, Maxwell's hypothesis, plane waves, radiation, antennas, wave guides.

Text: Skilling: Fundamentals of Electric Waves (Second Edition).

Prerequisite: Elementary Calculus.

Es-622(B) Electromagnetics II 5-0

Phasor notation; generalized coordinates; rectangular, cylindrical, and spherical harmonics; Bessel functions; Maxwell's equations for time varying fields; displacement current density; retarded potentials; circuit concepts from fields; impedance; skin effect; inductance; Poynting's theorem; propagation of plane waves; phase velocity and Snell's law; pseudo-Brewster angle; waves in imperfect media; guided waves.

Text: Ramo and Whinnery: Fields and Waves in Modern Radio (Second Edition).

Prerequisite: Es-621(C) and Ma-104(A).

Es-623(A) Electromagnetics III 4-0

A continuation of Es-622(B). TEM, TE, TM waves; rectangular and cylindrical wave guides; miscellaneous guiding systems; resonant cavities; fields from dipole antenna; gain; image antenna; field from rhombic antenna; antenna arrays; in-

duced EMF method; pseudo-Maxwell's equations; parabolic reflector; slot antenna; electromagnetic horns; biconical antenna; driving point impedance of cylindrical antenna; receiving antenna.

Text: Ramo and Whinnery: Fields and Waves in Modern Radio (Second Edition).

Prerequisite: Es-622(B).

Es-626(C) Guided Waves and Resonators 2-0

Application of Maxwell's equations to TEM propagation on open wire and coaxial lines, and TE and TM waves in the rectangular guide. Discussion of TE and TM modes in the circular guide and the coaxial line. Cavity resonance and equivalent circuits for resonators.

Text: Skilling: Fundamentals of Electric Waves (Second Edition); Instructor's notes.

Prerequisite: Es-615(C).

Es-726(B) Antennas, Transmission Lines 3-3

The engineering problems associated with the practical design of antennas, antenna systems, and transmission lines.

Text: Kraus: Antennas.

Prerequisite: Es-623(A).

Es-727(B) Antennas and Feed Systems 3-3

This course is intended to make the student familiar with the more common types of antennas and feed systems. The attack is essentially an engineering approach, applying to practical systems, to as great an extent as practicable, the mathematics and field theory presented in earlier courses. The laboratory work is directed to the measurement of field intensities, antenna patterns input impedances and feed systems.

Text: Kraus: Antennas.

Prerequisites: Es-615(C) and Es-626(C).

Es-821(C) Systems Lectures 0-1

A series of informational lectures covering recent developments, new publications, and faculty visits to industrial and military research and development laboratories.

Text: None.

Prerequisites: Es-214(C) and Es-114(C).

Es-822(C) Systems Lectures 0-1

A continuation of Es-821(C).

Text: None.

Prerequisite: Es-821(C).

Es-823(B) Systems Seminar 3-0

Groups of students undertake the overall specification and design of an integrated weapons, countermeasures, navigational, or communications system, under the instructor's consultation and guidance. Emphasis is on the integration of electronic devices and evaluation of system performance.

Texts: Miscellaneous.

Prerequisite: Es-327(B).

GEOLOGY

Ge Courses

Physical Geology ----------Ge-101(C)
Physical Geology ----------Ge-201(C)
Geology of Petroleum ----------Ge-241(C)
Determinative Mineralogy ----------Ge-302(C)
Petrology and Petrography ----------Ge-401(C)

Ge-101(C) Physical Geology 3-2

The study of the various geological phenomena. Topics discussed are: rock-forming minerals; igneous, sedimentary, and metamorphic rocks; weathering and erosion; stream sculpture; glaciation; surface and sub-surface waters; volcanism, dynamic processes; structural geology; and interpretation of topographic maps. Frequent reference is made to other than the prescribed textbook. The course stresses those topics of particular interest to the petroleum engineer.

Text: Longwell, Flint: Introduction to Physical Geology.

Prerequisite: Ge-401(C).

Ge-201(C) Physical Geology 3-0

Course content similar to Ge-101, but directed towards the specific needs of the Nuclear Engineering Groups.

Text: Longwell, Flint: Introduction to Physical Geology.

Prerequisite: None.

Ge-241(A) Geology of Petroleum 2-4

Seminars and discussion on the origin, accumulation, and structures which aid in the accumulation of petroleum, its general occurrence, and distribution. The following regions are studied: Eastern United States, Mid-Continent, Gulf Coast, Rocky Mountains, Pacific Coast, North America (except U. S.), West Indies, South America, Europe, Russia, Oceanica and Asia. This course is supplemented by reading assignments in the current petroleum and petroleum geology journals.

Text: Lalicker: Principles of Petroleum Geology.

Prerequisite: Ge-101(C).

Ge-302(C) Determinative Mineralogy 1-4

The lectures are designed to familiarize the student with the principles and techniques involved in determining minerals in the laboratory. The laboratory periods are spent in the determination of some fifty of the more common minerals by blowpipe, chemical, x-ray diffraction and crystallographic methods. The student is also made familiar with the methods employed in the use of chemical microscopy for the determination of certain elements.

Text: Lewis, Hawkins: Determinative Mineralogy; Dana, Ford: Textbook of Mineralogy.

Prerequisite: Cr-301(B) or Cr-311(B).

Ge-401(C) Petrology and Petrography 2-3

A series of lectures on the differentiation of magmas into the various igneous rock series on the basis of physical chemical theories; the characteristics, structures and textures of igneous rocks; the metamorphic rocks, mineral alteration, metamorphism and the resultant rock types. The laboratory work consists of the study of the various rocks in hand specimens, and in thin sections under the petrographic microscope. When practicable, the course is supplemented by trips to nearby localities to study rocks and minerals in the field.

Texts: Pirsson, Knopf: Rocks and Rock Minerals; Grout: Petrography and Petrology.

Prerequisite: Cr-301(B) or Cr-311(B).

INDUSTRIAL ENGINEERING

IE Courses (Summer Session)

Elements of Management and Industrial Engineering ----------IE-101(C)

IE-101(C) Elements of Management and Industrial Engineering 23-0

A period of eight weeks is devoted to a series of short courses in such areas as: Accounting, Business Law, Industrial Economics, Industrial Relations, Personnel Administration, Production Management, Principles of Organization, and Quality Control. The basic principles are presented together with their application to the solution of illustrative problems.

Text: To be assigned.

Prerequisite: None.

A certificate is awarded upon satisfactory completion

NAVAL POSTGRADUATE SCHOOL LECTURE PROGRAM

LP Lecture Program

NPS Lecture Program I ----------LP-101(L)

LP-101(L) NPS Lecture Program I 0-1

A series of weekly lectures to be delivered by authorities in education, government, and management designed to extend the knowledge of the officer students in the fields of world politics, international affairs, economics, and psychology.

Text: None.

Prerequisite: None.

NPS Lecture Program II ----------LP 102(L)

LP-102(L) NPS Lecture Program II 0-1

A continuation of LP-101(L).

Text: None.

Prerequisite: None.

MATHEMATICS

Ma Courses

Vector Algebra and Geometry ----------Ma-100(C)
Fundamentals of Analysis I ----------Ma-109(A)
Fundamentals of Analysis II ----------Ma-110(A)
Introduction to Engineering Mathematics ----------Ma-111(C)
Differential Equations and Infinite Series ----------Ma-112(B)
Introduction to Partial Differential Equations and Functions of a Complex Variable ------Ma-113(B)
Functions of a Complex Variable and Vector Analysis ----------Ma-114(A)
Differential Equations for Automatic Control ----------Ma-115(A)
Matrices and Numerical Methods -------Ma-116(A)
Vector Algebra and Geometry ----------Ma-120(C)
Introduction to Engineering Mathematics ----------Ma-121(C)
Differential Equations and Vector Calculus ----------Ma-122(B)
Orthogonal Functions and Partial Differential Equations ----------Ma-123(A)
Complex Variable ----------Ma-124(B)
Numerical Methods for Digital Computers ----------Ma-125(B)
Topics in Engineering Mathematics -----Ma-131(C)
Vector Analysis and Differential Equations ----------MA-132(B)
Differential Equations and Vector Mechanics ----------Ma-133(A)
Trigonometry ----------MA-140(C)
Algebra and Analytical Geometry ------MA-141(C)
Differential Equations ----------Ma-151(C)
Infinite Series ----------Ma-152(B)
Vector Analysis ----------Ma-153(B)
Differential Equations for Automatic Control ----------Ma-154(B)
Differential Equations for Automatic Control ----------Ma-155(A)
Partial Differential Equations ----------Ma-156(A)
Algebra, Trigonometry and Analytic Geometry ----------Ma-161(C)
Introduction to Calculus ----------Ma-162(C)
Calculus and Vector Analysis ----------Ma-163(C)
Intermediate Calculus and Differential Equations ----------MA-165(C)
Partial Derivatives and Multiple Integrals ----------Ma-181(C)
Vector Analysis and Differential Equations ----------Ma-182(C)
Fourier Series and Complex Variables ----------Ma-183(B)
Matrices and Numerical Methods -------Ma-184(A)
Laplace Transforms, Matrices and Variations ----------Ma-194(A)
Matrix Theory and Integration Theory --Ma-195(A)
Statistics ----------Ma-301(B)
Introduction to Statistics and Operations Analysis ----------Ma-320(C)
Probability and Statistics ----------Ma-321(B)
Introduction to Statistics ----------Ma-330(C)
Statistics ----------Ma-331(A)
Industrial Statistics I ----------Ma-351(B)
Industrial Statistics II ----------Ma-352(B)
Management Statistics ----------Ma-371(C)
Elementary Probability and Statistics ----------Ma-381(C)
Statistical Decision Theory ----------Ma-385(A)
Basic Probability ----------Ma-391(C)
Basic Statistics ----------Ma-392(B)
Mathematical Computation by Physical Means ----------Ma-401(A)
Digital Computation ----------Ma-420(A)
Digital and Analog Computation -------Ma-421(A)
Electronic Data Processing and Management Control ----------Ma-471(B)
Theory of Games ----------Ma-501(A)

Ma-100(C) Vector Algebra and Geometry 2-1

Outline of real number system. Vectors and their algebra. Analytic geometry of space; points, lines, and planes in scalar and vector notation. Determinants and linear systems. Special surfaces. The laboratory periods are devoted to a review of a selection from essential topics in trigonometry and analytic geometry.

Texts: Smith, Gale and Neelley: New Analytic Geometry; Weatherburn: Elementary Vector Analysis; USNPS Notes.

Prerequisite: A former course in plane analytic geometry.

Ma-109(A) Fundamentals of Analysis I 3-0

Extension of natural numbers to the real number system; basic theorems on limits; continuity and differentiation properties of functions; the definite integral and improper definite integrals; infinite series.

Texts: Landau: Foundations of Analysis; Courant: Differential and Integral Calculus, Volume I; Osgood: Functions of Real Variables.

Prerequisite: A former course in differential and integral calculus.

Ma-110(A) Fundamentals of Analysis II 3-0

Rigorous development of infinite series. Functions of a real variable. Riemann integral.

Texts: Courant: Differential and Integral Calculus, Volume I; Osgood: Functions of Real Variables; Hardy: Pure Mathematics.

Prerequisite: Ma-109(A).

Ma-111(C) Introduction to Engineering Mathematics 3-1

Partial differentiation; multiple integrals; hyperbolic functions. The laboratory periods are devoted to a review of selected topics in basic calculus.

Texts: Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Wylie: Advanced Engineering Mathematics.

Prerequisites: A former course in differential and integral calculus and Ma-100(C) or Ma-120(C) to be taken concurrently.

Ma-112(B) Differential Equations and Infinite Series 5-0

A continuation of Ma-111(C). First order ordinary differential equations; ordinary linear differential equations with constant coefficients; power series and power series expansion of functions; power series solution of ordinary differential equations; Fourier series.

Texts: Golomb and Shanks: Ordinary Differential Equations; Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-111(C).

Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable 3-0

A continuation of Ma-112(B). Solution of partial differential equations by means of series of orthogonal functions; analytic functions of a complex variable; line integrals in the complex plane; infinite series of complex variables; theory of residues.

Text: Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-112(B).

Ma-114(A) Functions of a Complex Variable and Vector Analysis 3-0

A continuation of Ma-113(B). Conformal mapping and applications; calculus of vectors with geometric applications; differential operators; line, surface and volume integrals involving vector fields; applications to heat flow and potential problems.

Text: Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-113(B).

Ma-115(A) Differential Equations for Automatic Control 3-0

Phase trajectories for linear and certain non-linear systems; singular points of non-linear equations; graphical solutions; stability investigations. The Laplace Transformation methods as used in ordinary initial value problems and partial differential equations; the inversion integral; calculation of inverse transforms by residues and by the Heaviside rules. Reduction of differential equations to non-dimensional form.

Texts: Minorsky: Introduction to Non-linear Mechanics; Churchill: Modern Operational Mathematics in Engineering; Stoker: Non-linear Vibrations; Thomson: Laplace Transformation.

Prerequisite: Ma-114(A).

Ma-116(A) Matrices and Numerical Methods 3-2

Finite differences, interpolation, numerical differentiation and integration; numerical solution of polynomial equations; numerical methods for initial value and boundary value problems involving ordinary and partial differential equations; solution of systems of linear algebraic equations; elementary properties and types of matrices; matrix algebra; latent roots and characteristic vectors of matrices; numerical methods for inversion of matrices.

Texts: Booth: Numerical Methods; Reprints of articles from scientific journals; Salvadori and Baron: Numerical Methods in Engineering.

Prerequisite: Ma-114(A).

Ma-120(C) Vector Algebra and Geometry 3-1

Real number system. Algebra of complex numbers. Vectors and their algebra. Analytic geometry of space; points, lines, and planes in scalar and vector notation. Determinants, matrices and linear systems; linear dependence. Special surfaces. Laboratory periods devoted to review of essential topics in trigonometry and plane analytic geometry.

Texts: Smith, Gale, Neelley: New Analytic Geometry; Weatherburn: Elementary Vector Analysis; Churchill: Introduction to Complex Variables; USNPS Notes.

Prerequisite: Former course in plane analytic geometry.

Ma-121(C) Introduction to Engineering Mathematics 3-1

Concepts of function, limit, continuity. Ordinary derivatives and applications. Rolle's theorem and the theorem of the mean. Taylor's series with a remainder. Partial derivatives. Implicit functions. Jacobians. Definite integral. Infinite series; Power series and Fourier series.

Texts: Franklin: Methods of Advanced Calculus;

Granville, Smith, Longley: Elements of the Differential and Integral Calculus.

Prerequisites: A former course in differential and integral calculus and Ma-120(C) to be taken concurrently.

Ma-122(B) Differential Equations and Vector Calculus 5-0

Multiple integrals. Line, surface and volume integrals. Divergence theorem. The theorems of Stokes, Green, and Gauss with applications. Vector calculus; intrinsic definition of the curl and divergence, the operator del, and vector formulation of integral theorems. Elementary differential equations. Hyperbolic functions.

Texts: Weatherburn: Elementary Vector Analysis; Phillips: Vector Analysis; Sokolnikoff and Sokolnikoff: Higher Mathematics.

Prerequisite: Ma-121(C).

Ma-123(A) Orthogonal Functions and Partial Differential Equations 5-0

Special functions; elliptic integrals, Gamma and Beta functions. Series solution of differential equations. Orthogonal functions. Elements of Sturm-Liouville Theory. Bessel functions. Legendre polynomials. Partial differential equations and solution of boundary value problems.

Texts: Churchill: Fourier Series and Boundary Value Problems; Sokolnikoff and Sokolnikoff: Higher Mathematics.

Prerequisite: Ma-122(B).

Ma-124(B) Complex Variable 3-0

Analytic functions. Cauchy's theorem and formula. Taylor and Laurent series. Theory of residues. Contour integration. Conformal mapping. Applications.

Texts: Churchill: Introduction to Complex Variable.

Prerequisite: Ma-123(A).

Ma-125(B) Numerical Methods for Digital Computers 2-2

Numerical methods for solution of systems of linear algebraic equations, polynomial equations, and systems of non-linear algebraic equations; finite differences, numerical interpolation, differentiation, integration; numerical methods for solving initial value and boundary value problems involving ordinary and partial differential equations. The laboratory periods cover sample problems solved on hand-operated keyboard calculators; emphasis is given to the methods which are most useful in large scale automatic digital computers.

Texts: Salvadori and Baron: Numerical Methods in Engineering; Booth: Numerical Methods.

Prerequisite: Ma-113(B) or Ma-123(A) or Ma-183(B).

Ma-131(C) Topics in Engineering Mathematics 5-2

Concepts of function and limit. Fundamentals of sequences and series. Taylor and Maclaurin series. Operations with series. Solution of algebraic equations. Determinants, matrices and systems of linear equations. Analytic geometry of space and the definition and algebra of vectors. Partial derivatives and multiple integrals. Laboratory periods will be devoted to essential review in analytic geometry and elementary calculus.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Weatherburn: Elementary Vector Analysis; Granville, Smith and Longley: Elements of the Differential and Integral Calculus.

Prerequisite: A former course in differential and integral calculus.

Ma-132(B) Vector Analysis and Differential Equations 5-0

Line, surface and volume integrals. Green's theorem and the divergence and Stokes' theorems. Derivatives of vector functions of one or more scalar variables. The del operator and the intrinsic definitions of divergence and curl. The integral theorems in vector form. Ordinary differential equations of first order. Linear differential equations with constant coefficients. Hyperbolic, Gamma and Beta functions.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Weatherburn: Advanced Vector Analysis.

Prerequisite: Ma-131(C).

Ma-133(A) Differential Equations and Vector Mechanics 5-0

Applications of ordinary differential equations. Stability criteria. Total differential equations and systems of differential equations. The vector equations of motion. Irrotational, solenoidal and linear vector fields. Fourier series. Partial differential equations and introduction to solution of boundary value problems in series of orthogonal functions.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Weatherburn: Advanced Vector Analysis.

Prerequisite: Ma-132(B).

Ma-140(C) Trigonometry 3-0

The trigonometric functions of the general angle.

Identities. Properties of the triangle. Radian measure. Graphs of trigonometric functions. Inverse functions. Use of tables. Applications.

Text: Brink: A First Year of College Mathematics.

Prerequisite: A previous course in elementary algebra.

Ma-141(C) Algebra and Analytic Geometry 5-0

Review of elementary algebraic operations. Linear equations. Simultaneous equations. Determinants. The quadratic equation. Binomial theorem. Progressions. Logarithms. Introduction to complex numbers. Variables and functions of variables. Coordinate representation of functions, graphs. Elementary equations and graphs of the conics. Introduction to solid analytic geometry.

Text: Brink: A First Year of College Mathematics.

Prerequisites: A previous course in elementary algebra and Ma-140(C) or equivalent. (The latter may be taken concurrently).

Ma-151(C) Differential Equations 5-0

Review of calculus. Partial derivatives. Polar coordinates and change of variables. Elements of differential equations: first order; linear; and total, with condition of integrability.

Texts: Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Golomb and Shanks: Differential Equations.

Prerequisite: A former course in differential and integral calculus.

Ma-152(B) Infinite Series 3-0

Convergence of a series, uniform convergence. Taylor series in one and two variables; associated approximation methods. Expansion of function in Fourier series; even and odd functions. Series solution of differential equation, introducing method of Frobenius.

Texts: Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Sokolnikoff and Sokolnikoff: Higher Mathematics for Engineers and Physicists.

Prerequisite: Ma-151(C) or equivalent (May be taken concurrently.)

Ma-153(B) Vector Analysis 3-0

Differential and integral relations involving vectors. Gradients, divergence and curl. Normals and tangents to lines and surfaces. Line and surface integrals. Theorems of Gauss, Green, and Stokes, and related integral formulas.

Texts: Phillips: Vector Analysis; Weatherburn: Elementary Vector Analysis; Weatherburn: Advanced Vector Analysis.

Prerequisite: Ma-120(C).

Ma-154(B) Differential Equations for Automatic Control 3-0

Systems of linear differential equations. Operational mathematics for solving differential and elementary integral equations. Phase-plane relations for non-linear second-order differential equations.

Texts: Cohen: Differential Equations; Churchill: Modern Operational Mathematics.

Prerequisites: Ma-120(C) and Ma-151(C) or equivalent.

Ma-155(A) Differential Equations for Automatic Control 3-0

Systems of linear differential equations. Laplace transform for solving ordinary differential equations. Inversion integral. Phase-plane relations for non-linear differential equations. Stability criteria.

Texts: Cohen: Differential Equations; Churchill: Modern Operational Mathematics; Stoker: Nonlinear Vibrations; Minorsky: Introduction to Nonlinear Mechanics.

Prerequisite: Ma-124(B), or equivalent.

Ma-156(A) Partial Differential Equations 3-0

Solution of boundary value problems by separation of variables. Orthogonal functions and introduction to Sturm-Liouville theory. Problems involving expansions in Bessel functions and Legendre polynomials.

Text: Churchill: Fourier Series and Boundary Value Problems.

Prerequisite: Ma-152(B).

Ma-161(C) Algebra, Trigonometry and Analytic Geometry 5-0

Review of elementary algebraic operations. Exponent laws and logarithms. Variables and functions of variables. Coordinate representation of functions; graphs. The trigonometric functions. The straight line and its slope. Simultaneous linear equations. The quadratic equation. Elementary equations of the conics.

Text: Brink: A First Year of College Mathematics.

Prerequisite: None.

Ma-162(C) Introduction to Calculus 5-0

The limit concept. The derivatives of elementary functions. Elementary applications of derivatives. Differentials, higher order derivatives and curvature. The integral as an antiderivative and as an area. Elementary applications of integration.

Text: Granville, Smith and Longley: Elements of the Differential and Integral Calculus.

Prerequisite: Ma-161(C) or satisfactory evidence of competence in analytic geometry.

Ma-163(C) Calculus and Vector Analysis 4-0

Elementary vector operations. Partial derivatives, total derivatives and total differentials with applications. Partial and multiple integrals. Differentiation of vectors; gradient, divergence and curl. Introduction to line integrals.

Texts: Phillips: Vector Analysis; Granville, Smith and Longley: Elements of the Differential and Integral Calculus.

Prerequisite: Ma-162(C) or a recent course in differential and integral calculus.

Ma-165(C) Intermediate Calculus and Differential Equations 5-0

Elements of solid analytic geometry. Partial derivatives. Multiple integrals. Hyperbolic functions. Geometric fundamentals of first-order differential equations. Solution of first-order equations. Linear differential equations with constant soefficients. Applications. Systems of equations.

Texts: Smith, Gale and Neelley: New Analytic Geometry; Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Golomb and Shanks: Elements of Ordinary Differential Equations.

Prerequisite: Ma-162(C).

Ma-181(C) Partial Derivatives and Multiple Integrals 4-1

Review of elementary calculus. Partial and total derivatives. Gradients and their physical interpretations. Line integrals. Double and triple integrals. Introduction to ordinary differential equations. Physical applications.

Texts: Granville, Smith and Longley: Differential and Integral Calculus; Sokolnikoff and Sokolnikoff: Higher Mathematics; Kaplan: Advanced Calculus.

Prerequisites: A former course in differential and integral calculus, and Ma-100(C) or Ma-120(C) to be taken concurrently.

Ma-182(C) Vector Analysis and Differential Equations 5-0

Vector differentiation. Vector integral relations. Physical applications. Ordinary first order differential equations. Higher order linear differential equations. Systems of differential equations. Physical interpretations. Infinite series.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Phillips: Vector Analysis.

Prerequisites: Ma-100(C) and Ma-181(C).

Ma-183(B) Fourier Series and Complex Variables 5-0

Expansion of functions. Series solution of differential equations. Fourier series and solution of partial differential equations. Algebra of complex numbers. Analytic functions of a complex variable, and the elementary transcendental functions. Conformal maps. Cauchy's Theorem. Residues.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Churchill: Fourier Series and Boundary Value Problems; Churchill: Complex Variables.

Prerequisite: Ma-182(C).

Ma-184(A) Matrices and Numerical Methods 3-0

Algebra of matrices. Characteristic values of matrices. Applications of matrices. Notation of finite differences. Numerical differentiation and numerical integration.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Margenau and Murphy: Mathematics of Physics and Chemistry.

Prerequisite: Ma-183(B).

Ma-194(A) Laplace Transforms, Matrices and Variations 5-0

Definition and properties of Laplace transforms. Solution of ordinary and partial differential equations by Laplace transforms. Algebra of matrices. Characteristic values of matrices and differential operators. Introduction to calculus of variations.

Texts: Churchill: Modern Operational Mathematics; Margenau and Murphy: Mathematics of Physics and Chemistry; Burington and Torrance: Higher Mathematics.

Prerequisite: Ma-183(B).

Ma-195(A) Matrix Theory and Integration Theory 4-0

Algebra of matrices; characteristic values of matrices; Hamilton-Cayley and Sylvester's theorems; matrix methods in the solution of systems of differential equations. Basic concepts in the theories

of Riemann, Lebesgue, and Stieltjes integrals with emphasis on the applications of these theories to probability theory.

Texts: Frazer, Duncan and Collar: Elementary Matrices; McKinsey: Introduction to the Theory of Games; Munroe: Introduction to Measure and Integration.

Prerequisite: Ma-183(B). (May be taken concurrently).

Ma-301(B) Statistics 3-2

Fundamental principles of probability. Probability distributions with special emphasis on the binomial, Poisson and normal distributions. Simple and multiple regressions and correlation. Distribution of mean, chi-square, variance, t, and F. Analysis of variance. Tests of statistical hypotheses.

Texts: Wilks: Elementary Statistical Analysis; Hoel: Introduction to Mathematical Statistics.

Prerequisite: Ma-123(A) or Ma-113(B). (May be taken concurrently.)

Ma-320(C) Introduction to Statistics and Operations Analysis 4-0

Frequency distributions. Mean value and standard deviation. Basic probability theory for discrete and continuous variables. Probability of a hit on an evasive target. Probability of detection. Analysis of combat operations. Basic probability distributions. Sampling theory.

Texts: C. E. Clark: Introduction to Statistics; Wilks: Elementary Statistical Analysis; Morse and Kimball: Operations Research; Granville, Smith and Longley: Differential and Integral Calculus.

Prerequisite: A former course in differential and integral calculus.

Ma-321(B) Probability and Statistics 4-2

Tabulation and graphical presentation of frequency distributions from observational data. Elementary rules for calculation of probabilities with applications. Random variables and probability distributions. The binomial, Poisson, and normal distributions. Chi-square, Gosset's t, and variance quotient distributions. Regression and correlation, Estimation and testing of statistical hypotheses. Applications in quality control and acceptance sampling.

Text: Cramer: The Elements of Probability Theory.

Prerequisite: Ma-123(A) or Ma-113(B).

Ma-330(C) Introduction to Statistics 2-0

Preliminary considerations in the analysis of observations. Measures of central tendency and dispersion. Elementary probability. The Poisson, Bernoulli and normal distributions. Some applications to sampling.

Text: Wilks: Elementary Statistical Analysis.

Prerequisite: Ma-121(C) or equivalent.

Ma-331(A) Statistics 4-2

A continuation of Ma-330(C). Definition and laws of probability over an event space. Joint frequency functions. Tests of statistical hypotheses. Large and small sampling theory. Correlation and regression methods in multivariate problems. Introduction to the theory of estimators of population parameters and their distributions. Applications to problems in aerology.

Texts: Hoel: Introduction to Mathematical Statistics (Second Edition); Best and Panofsky: Some Applications of Statistics to Meteorology.

Prerequisite: Ma-134(B) or Ma-330(C).

Ma-351(B) Industrial Statistics I 3-2

Frequency distributions. Elements of the theory of probability. The hypergeometric, binomial, Poisson, and normal probability distributions. Sampling distributions of the mean, variance, and range. Acceptance sampling by attributes.

Texts: Duncan: Quality Control and Industrial Statistics; Bowker and Lieberman: Handbook of Industrial Statistics.

Prerequisite: Ma-113(B).

Ma-352(B) Industrial Statistics II 2-2

Double and sequential acceptance sampling by attributes. Acceptance sampling by variables. Control charts. Statistical tests. Analysis of variance and design of experiments. Regression and correlation. Illustrations from selected ordnance publications.

Texts: Duncan: Quality Control and Industrial Statistics; Bowker and Lieberman: Handbook of Industrial Statistics.

Prerequisite: Ma-351(B).

Ma-371(C) Management Statistics 2-2

The problem of observing and interpreting statistical data, with special regard to the design and control of sampling methods, the calculation of statistical measures, the affiliation of statistical

methods to evaluation, trend analysis, correlation, and quality control, and the presentation of statistical results.

Text: Hanson: Managerial Statistics.

Prerequisite: Ma-161(C) or equivalent.

Ma-381(C) Elementary Probability and Statistics 4-2

Frequency distributions. Elements of the theory of probability. The binomial, Poisson and normal probability distributions. Elements of sampling theory and statistical inference with applications. Confidence intervals. Bivariate distributions. Regression lines and simple correlation. Applications in the field of the group.

Texts: Wilks: Elementary Statistical Analysis; Cramer: The Elements of Probability Theory; Best and Panofsky: Applications of statistics to Meteorology. (Aerology groups only.)

Prerequisite: Ma-163(C) or Ma-181(C).

Ma-385(A) Statistical Decision Theory 3-0

Basic concepts; relation of statistical decision functions to the theory of games; applications in the planning of operational evaluation trials.

Texts: Wald: Statistical Decision Functions; Tucker: Introduction to Statistical Decision Functions, USNPS thesis; Smith: Application of Statistical Methods to Naval Operational Testing, USNPS, thesis.

Prerequisites: Ma-383(A) and Ma-501(A). (The latter may be taken concurrently.)

Ma-391(C) Basic Probability 4-2

Definitions of probability and the basic rules of computation. Probability distributions, discrete and continuous; the common distributions. Markov chains and stochastic processes. Military applications. Queueing theory. Central limit theorem.

Texts: Monroe: Theory of Probability; Uspensky: Introduction to Mathematical Probability; Burlington and May: Probability and Statistics.

Prerequisite: Ma-181(C) (May be taken concurrently.)

Ma-392(B) Basic Statistics 5-2

Basic statistical concepts. Theory of sampling. Tests of hypotheses. Correlation and regression analysis. Analysis of variance and design of experiments. Sequential analysis. Time series.

Texts: Ostle: Statistics in Research; Mood: Introduction to the Theory of Statistics; Burlington and May: Probability and Statistics.

Prerequisite: Ma-391(C).

Ma-401(A) Analog Computers 2-2

Elementary analog devices which may be used to perform addition, multiplication, function generation, integration, etc. Combinations of such devices for solution of differential equations, systems of linear equations, algebraic equations, harmonic analysis, etc. Digital differential analyzers.

Texts: W. W. Soroka: Analog Methods in Computation and Simulation; Murray: Theory of Mathematical Machines; Reprints of articles from scientific periodicals.

Prerequisite: Ma-113(B) or Ma-123(A).

Ma-420(A) Digital Computation 2-2

Logical design of digital computers. Programming and coding for general-purpose digital and differential analyzer computers. Laboratory operation of computing machines. Applications.

Texts: Programming Manuals; Booth and Booth: Automatic Digital Calculators.

Prerequisites: Ma-116(B) or Ma-125(B).

Ma-421(A) Digital and Analog Computation 3-2

Logical design of digital and analog computers. Programming and coding for general-purpose digital, differential analyzer, and analog computers. Laboratory operation of computing machines. Applications to problems in engineering.

Texts: Programming Manuals; Booth and Booth: Automatic Digital Calculators; Korn and Korn: Electronic Analog Computers.

Prerequisite: Ma-116(A) or Ma-125(B).

Ma-471(B) Electronic Data-Processing and Management Control 3-2

Study and analysis of intermediate and large-scale electronic digital data-processing machines in the solution of management problems. Scientific approach to management problems. Case studies in inventory control, material accounting, personnel accounting or applications of immediate interest to the group.

Texts: Kozmetsky and Kircher: Electronic Computers and Management Control. Periodicals and literature of government and industrial users of electronic data-processing equipment.

Ma-501(A) Theory of Games 3-2

The basic concepts and foundations for the theory of games, such as game, play, strategy, complete and incomplete information, zero-sum games, etc.

The structures of various games, particularly two-person zero-sum games with finite and infinite strategies. Games of timing. The related algebra of matrices and bilinear forms to yield methods for evaluating games. The minimax theorem and properties of minimax strategies. Games involving three or more persons and the effects of coalitions.

Texts: Dresher: Theory and Applications of Games of Strategy (RAND Report); McKinsey: Introduction to the Theory of Games; USNPS Notes.

Prerequisites: Ma-195(A) and Ma-392(C) or the equivalent.

MECHANICS

Mc Courses

Engineering Mechanics I ---------- Mc-101(C)
Engineering Mechanics II ---------- Mc-102(C)
Applied Mechanics ---------- Mc-191(C)
Methods in Dynamics ---------- Mc-201(A)
Vibrations ---------- Mc-311(A)
Exterior Ballistics ---------- Mc-401(A)
Mechanics of Gyroscopic Instruments --- Mc-402(A)
Kinematics of Guidance ---------- Mc-403(A)
Interior Ballistics ---------- Mc-421(A)

Mc-101(C) Engineering Mechanics I 2-2

Review of statics; free-body diagrams; distributed forces; centroids; moments and products of inertia of areas; hydrostatics; friction; general principles of dynamics; dimensional analysis; kinematics of a particle; relative and absolute time rate of change of a vector; Coriolis acceleration.

Text: Housner and Hudson: Applied Mechanics.

Prerequisite: A previous course in mechanics is desirable. Ma-100(C) or Ma-120(C) to be taken concurrently.

Mc-102(C) Engineering Mechanics II 2-2

Dynamics of a particle; impulse and momentum; work and energy; potential; conservation of energy; vibrating systems, free and forced, with and without damping; impact; dynamics of rigid bodies; moments and products of inertia; principal axes of inertia; the gyroscope.

Text: Housner and Hudson: Applied Mechanics.

Prerequisite: Mc-101(C).

Mc-191(C) Applied Mechanics 4-0

Review of statics. General principles of dynamics; kinematics, Coriolis acceleration, integrals of Newton's law and their physical meaning. Dynamics of rigid bodies; motion of a gyroscope. The control of dynamical systems; feedback and stability.

Texts: Housner and Hudson: Applied Mechanics: Statics; Housner and Hudson: Applied Mechanics: Dynamics; USNPS Notes.

Prerequisite: A previous course in mechanics is desirable. Ma-120(C) to be taken concurrently.

Mc-201(A) Methods in Dynamics 2-2

The principles of linear momentum, angular momentum, work and energy, power and energy, conservation of energy, virtual work, and d'Alembert are developed and discussed in detail. This work is followed by a development and interpretation of Lagrange's equations of motion. Application of these various principles to obtain the differential equations of motion of dynamical systems is given particular attention. Numerous exercises in the writing of differential equations of motion are assigned; some of these are designed to furnish practice in the formulation of the differential equations for systems of variable mass.

Texts: Synge and Griffith: Principles of Mechanics; Timoshenko and Young: Advanced Dynamics.

Prerequisite: Mc-102(C).

Mc-311(A) Vibrations 3-2

Kinematics of vibrations; free and forced vibrations of systems with one degree of freedom; theory of vibration measuring instruments and of vibration insulation; systems with many degrees of freedom; normal modes of vibration; computation of fastest and slowest modes by matrix methods; vibrations of strings, beams, shafts and membranes; Rayleigh's method; Stodola's method; critical speeds; self-excited vibrations; effect of impact on elastic structures.

Texts: Thomson: Mechanical Vibrations (2nd edition); Den Hartog: Mechanical Vibrations (3rd edition); Frankland: Effects of Impact on Simple Elastic Structures (TMB Report 481).

Prerequisites: Ma-114(A), Mc-102(C) and either ME-500(C) or Ae-211(C).

Mc-401(A) Exterior Ballistics 3-0

Topics presented include density and temperature structure of the atmosphere; air resistance; elastic waves in air; numerical integration of differential equations of motion under standard conditions by use of the electronic digital computer; differential corrections for abnormal conditions; weighting factors; general aerodynamic force system and equations of angular motion of a spinning axially-symmetric projectile; stability; yaw and pitch of repose; drift; trailing; swerve; windage jump; effects of yaw in gun, eccentric mass, and muzzle blast; rocket motion and launching effects.

Texts: Ritter: A Course in Exterior Ballistics; McShane, Kelley and Reno: Exterior Ballistics.

Prerequisite: Mc-102(C).

Mc-402(A) Mechanics of Gyroscopic Instruments 3-0

Review of the vector kinematics and dynamics involved in the angular motion of rigid bodies; steady free and forced precession and general motion of a gyro; stability of a free gyro; gyroscopic moment of an unsymmetrical gyro; the gyrocompass; gyro angular velocity indicator; the stable platform.

Texts: Synge and Griffith: Principles of Mechanics (Second Edition); Timoshenko and Young: Advanced Dynamics.

Prerequisite: Mc-102(C).

Mc-403(A) Kinematics of Guidance 3-0

Kinematics and geometry of guidance and interception systems; special coordinates; inertial reference frames; accelerometers; inertial guidance; introduction to autopilots; introduction to optimum rocket trajectories.

Texts: Locke: Guidance; USNPS Notes.

Prerequisite: Mc-402(A).

Mc-421(A) Interior Ballistics 2-0

Basic thermodynamics of interior ballistics including methods of determining the adiabatic flame temperature, specific heat and number of moles of powder gas. These basic topics are followed by a detailed study (including computational exercises) of the linear system of interior ballistics of Hirschfelder developed under NDRC auspices.

Texts: Hirschfelder and Sherman: Simple Calculation of Thermochemical Properties for Use in Ballistics (OSRD Report 935); Curtiss and Wrench: Interior Ballistics (OSRD Report 6468).

Prerequisites: Ma-111(C), Mc-102(C) and Ch-631(A).

MECHANICAL ENGINEERING

ME Courses

Engineering Thermodynamics ----------ME-111(C)
Engineering Thermodynamics ----------ME-112(B)
Engineering Thermodynamics ----------ME-122(C)
Engineering Thermodynamics ----------ME-131(C)
Engineering Thermodynamics ----------ME-132(C)
Engineering Thermodynamics ----------ME-141(C)
Engineering Thermodynamics ----------ME-142(A)
Engineering Thermodynamics ----------ME-143(A)
Thermodynamics ----------ME-150(C)
Marine Power Plant Equipment ---------ME-210(C)
Marine Power Plant Equipment ---------ME-211(C)
Marine Power Plant Equipment ---------ME-212(C)
Marine Power Plant Analysis and Design ----------ME-215(A)
Marine Power Plant Analysis and Design ----------ME 216(A)
Internal Combustion Engines ----------ME-217(C)
Marine Power Plant Equipment ---------ME-221(C)
Marine Power Plant Equipment ---------ME-222(C)
Marine Power Plant Analysis ----------ME-223(B)
Nuclear Power Plants ----------ME-240(B)
Nuclear Power Plants ----------ME-241(A)
Nuclear Power Plants ----------ME-242(A)
Nuclear Power Plants ----------ME-246(B)
Nuclear Reactor Laboratory ----------ME-250(A)
Heat Transfer ----------ME-310(B)
Heat Transfer ----------ME-320(B)
Heat Transfer ----------ME-350(B)
Hydromechanics ----------ME-410(B)
Hydromechanics ----------ME-411(C)
Hydromechanics ----------ME-412(A)
Hydromechanics ----------ME-421(C)
Hydromechanics ----------ME-422(B)
Hydromechanics ----------ME-441(B)
Compressible-fluid Flow ----------ME-442(B)
Strength of Materials ----------ME-500(C)
Strength of Materials ----------ME-511(C)
Strength of Materials ----------ME-512(A)
Theory of Elasticity ----------ME-513(A)
Strength of Materials ----------ME-522(B)
Strength of Materials ----------ME-541(C)
Strength of Materials ----------ME-542(B)
Elements of Dynamic Structural Analysis ----------ME 550(B)
Materials Testing Laboratory ----------ME-601(C)
Materials Testing Laboratory ----------ME-611(C)
Experimental Stress Analysis ----------ME-612(A)
Experimental Stress Analysis ----------ME-622(B)
Kinematics of Machinery ----------ME-700(C)
Mechanics of Machinery ----------ME-710(B)
Mechanics of Machinery ----------ME-711(B)
Dynamics of Machinery ----------ME-712(A)
Advanced Dynamics of Machinery ------ME 713(A)
Vibrations ----------ME 730(A)
Kinematics and Machine Design --------ME-740(C)
Machine Design ----------ME-811(C)
Machine Design ----------ME-812(B)
Machine Design ----------ME-820(C)
Machine Design ----------ME-830(C)
Manufacturing Engineering ----------ME-840(C)
Special Problems in Mechanical Engineering ----------ME-900(A)

ME-111(C) Engineering Thermodynamics 4-2

Stored and transitional energies, their accounting by energy equations in dynamic and chemical processes. Aspects of reversibility, thermodynamic scale of temperature, entropy of energy and the entropy function. Second and Third Laws of thermodynamics, Maxwell relations. Phase rule, thermodynamic properties of liquids and vapors in equilibrial and metastable states, property tables and diagrams, representative reversible and irreversible processes in vapor and liquid phases. Property relations, tables and diagrams for ideal or quasi-ideal gases, representative reversible and irreversible processes with these. Associated problems. This course is the first of a coordinated sequence containing ME-112 or 122, 211 or 221, et cetera.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: Ma-112(B).

ME-112(B) Engineering Thermodynamics 4-2

Properties of mixtures of quasi-ideal gases, low-pressure gas-vapor mixtures and related indices, representative processes with these, multi- and mono-pressure hygrometric diagrams. Combustion of fuels, material and energy balances, fuel calorimetry, equilibrium and equilibrium constant, rich-mixture and thin-mixture combustion, flame temperatures. As time permits, non-ideal gases and their p-v-T correlation by equation and by compressibility diagrams, residual enthalpy and entropy functions and their determination from compressibility and throttling data, representative processes and generation of thermodynamic diagrams. Associated problems. The course is in continuation of ME-111.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-111(C).

ME-122(C) Engineering Thermodynamics 3-2

Studies included are as indicated for course ME-112 except for omission of considerations of the thermodynamic properties and property correlations for non-ideal gases. This course is in continuation of ME-111.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-111(C).

ME-131(C) Engineering Thermodynamics 4-2

Stored and transitional energies, their accounting by energy equations in dynamic and chemical processes. Aspects of reversibility, thermodynamic scale of temperature, entropy of energy and the entropy property, Second and Third Laws of thermodynamics, Maxwell relations. Phase rule, thermodynamic characteristics of liquids and vapors. Property relations, tables and diagrams for ideal or quasi-ideal gases and representative reversible and irreversible processes with these. Gas mixtures, low-pressure gas-vapor mixture and their indices, representative processes with them, multi- and mono-pressure hygrometric charts. Elements of atmospheric thermodynamics.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: Ma-112(B).

ME-132(C) Engineering Thermodynamics 3-2

Materials and energy balance in combustion. Spark-ignition engine and simpler gas-turbine power installations and their performance characteristics. Subsonic and supersonic flow of compressible fluids, reversible and shockwise, in nozzle, diffuser or duct; associated wall forces and their operation in turbine or compressor blading and in jet propulsion or the rocket motor. Elements of heat transmission. Sequent to ME-131, those thermodynamic applications are considered which are of major concern in aircraft power installations.

Text and Supplement: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Kaye: Gas Tables.

Prerequisite: ME-131(C).

ME-141(C) Engineering Thermodynamics 4-2

The fundamental concepts of thermodynamics; energy and its accounting; availability and entropy of energy; the thermodynamic properties of pure substances and their changes in various processes, including chemical interaction. Emphasis is placed on those topics essential for subsequent studies of torpedo power plants, jet engines, explosives and similar applications where non-standard fluids are involved. The laboratory periods are used for student solution of practical problems chosen to illustrate the principles discussed in the classroom.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: Ma-113(B).

ME-142(A) Engineering Thermodynamics 2-2

Organization of the thermodynamic properties of non-ideal gases through the use of the residual functions, preparation and use of thermodynamic diagrams for simple systems of ideal and non-ideal gases and for complex systems in chemical equilibrium, heat and work effects in representative processes involving complex mixtures such as the products of combustion. This course is a continuation of ME-141(C). The laboratory periods are used for students solution of practical problems to illustrate the principles discussed in the classroom.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-141(C).

ME-143(A) Engineering Thermodynamics 4-4

Thermodynamic aspects of the flow of compressible fluids in nozzle, diffuser and duct, compressive shocks, dynamics of the jet and diverted flow. Application of thermodynamic facilities to power plants such as jet engines and torpedo motors which operate on non-standard fluids. Turbine nozzle and blading design factors and performance indices. Elements of heat transfer. Associated problems.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Church: Steam Turbines.

Prerequisite: ME-142(C).

ME-150(C) Thermodynamics 4-2

Fundamental aspects of energy accounting at molecular levels; the mechanical availability of such energy. Thermodynamic properties of gases at lower and at extreme pressures, and their correlation in connection with representative processes. The course is adapted more particularly to the needs of the interior-ballistics engineer.

Text and Supplement: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Kaye: Gas Tables.

Prerequisite: Ma-181(C).

ME-210(C) Marine Power Plant Equipment 3-2

Thermodynamic aspects of flow of compressible fluids in nozzle, diffuser, compressive shocks, dynamics of the jet and diverted flow. Thermodynamic

aspects of the turbine, impulse and reaction types. Power-generation cycles employing condensing fluids, Rankine cycle and variations, binary-vapor cycles. Power generation cycles employing non-condensing fluids, basic internal combustion turbine cycle, variations of basic cycle, air-standard and real-fuel performance.

Text and Supplement: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Keyes: Thermodynamic properties of Steam.

Prerequisite: ME-112(B) or ME-122(C).

ME-211(C) Marine Power Plant Equipment 3-2

Steam power plant cycles, internal combustion power cycles, elementary gas turbine power plant, influences of regenerative pre-heating and of re-heating, performance indices. Thermodynamic aspects of the flow of compressible fluids in nozzle, diffuser and duct, compressive shocks, dynamics of jet and diverted flow. Associated problems and laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-112(B).

ME-212(C) Marine Power Plant Equipment 3-4

Thermodynamic aspects of the turbine, impulse and reaction types, of the reciprocating engine, the gas compressor and blower. Refrigeration and heat pump cycles, refrigerants, multi-level refrigeration. Air conditioning; requirements and equipment, associated laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-211(C).

ME-215(A) Marine Power Plant Analysis and Design 2-4

Studies of the methods and procedures employed in the over-all planning of naval ships from the viewpoint of the power plant engineer, their principal plant components and various practical and military factors which influence the design. Project work includes preliminary methods of estimating for a hypothetical naval ship: the hull, main engine and auxiliary power requirements, inter-relationship of individual equipment items, and computation of various ship and plant performance indices. The time is distributed variously between lectures, student project work, seminar and, upon occasion, lectures by visiting authorities in specialized fields of naval marine engineering.

Texts: Seward: Marine Engineering; Bureau of Ships publications and data; Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisites: ME-212(C), ME-310(B), and ME-411(C).

ME-216(A) Marine Power Plant Analysis and Design. 2-4

This course, in continuation of ME-215(A), carries to completion the project work of the latter, as required, with additional project work in preliminary design investigation of main propulsion turbines and other major equipment items. The time is distributed variously between lectures, student project work, seminar and, upon occasion, lectures by visiting authorities in specialized fields of naval marine engineering.

Texts: Seward: Marine Engineering; Labberton: Marine Engineering; Church: Steam Turbines; Bureau of Ships publications and data; Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-215(A).

ME-217(C) Internal Combustion Engines 3-2

Analysis of basic spark-ignition and compression ignition cycles, real-fuel cycles and effects of dissociation, combustion processes, effects of detonation, variations of real engine performance from ideal performance, supercharged and throttled cycles. Spark-ignition engine combustion chambers, carburetion, inlet and exhaust systems, effects of ignition timing. Compression-ignition engine combustion chambers, injection systems, analysis of injection phenomena and variables affecting performance. Laboratory work includes engine tests to determine speed-torque characteristics, fuel consumption rates, effect of injection systems variables upon engine performance, volumetric efficiencies, etc.

Texts: Lichty: Internal Combustion Engines: Taylor and Taylor: Internal Combustion Engines.

Prerequisite: ME-112(B) or ME-122(C).

ME-221(C) Marine Power Plant Equipment 3-2

Steam power plant cycles, influences of regenerative feed heating and of reheating, performance indices. Internal combustion power cycles, elementary gas turbine power plant, influence of regenerative preheating and of reheating, performance indices. Thermodynamic aspects of flow of compressible fluids in nozzle, diffuser and duct, dynamics of jet and of diverted flow. Elements of heat transmission. Associated problems and laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-122(C).

ME-222(C) Marine Power Plant Equipment 3-4

Thermodynamic aspects of the turbine, impulse and reaction types, of the reciprocating engine, the gas compressor and blower. Refrigeration and heat pump cycles, refrigerants, multi-level refrigeration, air conditioning requirements and equipment. Associated laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-221(C).

ME-223(B) Marine Power Plant Analysis 2-4

Preliminary methods of estimating for a hypothetical naval ship the hull, main engine and auxiliary power requirements, inter-relationship of individual equipment items, and computation of various plant and ship performance indices. Preliminary design investigation of main propulsion turbines and other power plant equipment. Heat balance and flow diagrams.

Texts: Seward: Marine Engineering; Labberton: Marine Engineering; Church: Steam Turbines; Bureau of Ships publications and data.

Prerequisites: ME-222(C) and ME-421(C) or ME-411(C).

ME-240(B) Nuclear Power Plants 4-0

A general survey of nuclear power with emphasis on the relation of the reactor to power sources, present and future. Nuclear particles, energies and properties. Nuclear reactions, radioactivity, decay. Scattering and diffusion of neutrons. Nuclear reactor principles, types. Problems of power removal and utilization. Reactor core considerations. Elements of reactor economics, feasibility. Shielding problems. Discussion of world future energy source.

Text: Murray: Introduction to Nuclear Engineering.

Prerequisites: ME-111(C) and Ph-610(B).

ME-241(A) Nuclear Power Plants 3-2

The first of a two-term series, ME-241 and ME-242 covering engineering aspects of nuclear power reactors. Reactor types, properties and criteria for selection. History and organization of atomic energy effort. Advanced heat transfer and thermodynamics of characteristic cycles. Elementary nuclear and thermal core and plant design. Shielding. Economics of nuclear plants.

Texts: Murray: Introduction to Nuclear Engineering; Glasstone and Edlund: Elements of Nuclear Reactor Theory; USGPO: Liquid Metals Handbook.

Prerequisites: ME-310(B) and Ph-642(B).

ME-242(A) Nuclear Power Plants 3-2

Reactor control methods and programs. Plant stability, kinetic behavior, poisoning. Detailed studies of existing naval reactor plants. Material in this course will be partly of a classified nature.

Texts: Murray: Introduction to Nuclear Engineering; Glasstone and Edlund: Elements of Nuclear Reactor Theory; USGPO: Liquid Metals Handbook.

Prerequisite: ME-241(A).

ME-246(B) Nuclear Power Plants 3-0

A general survey of nuclear reactor principles, intended for other than mechanical engineering students. Essential elements of thermodynamics, heat transfer, and neutron physics. Reactor principles, reactor power plant descriptions, shielding, materials, corrosion, and associated problems.

Text: Murray: Introduction to Nuclear Engineering.

Prerequisites: Ph-631(B) or Ph-730(A). (May be taken concurrently.)

ME-250(A) Nuclear Reactor Laboratory 0-4

Laboratory experiments using the AGN-201 Reactor covering reactor operation, monitoring the reactor, control rod calibration, measurement of the effect of absorption reactivity, measurement of thermal cross-sections and danger coefficient tests, relative calibration of foils, temperature of reactor by foil measurement, measurement of reactor core buckling and power level calibration, measurement of diffusion length and age in water and shielding evaluation. Experiments on a reactor simulator investigating reactor behavior and control during normal operation and under unusual conditions.

Texts: Hughes: Pile Neutron Research; Glasstone and Edlund: Elements of Nuclear Reactor Theory; Glasstone: Principles of Nuclear Reactor Engineering.

Prerequisite: ME-241(A).

ME-310(B) Heat Transfer 4-2

General manners of energy transition by temperature potential, characteristic thermal circuits, concepts and correlation of individual and overall heat transfer coefficients. Fourier's general law of conduction, applications to representative steady-state situations and unsteady-state condition, Schmidt and relaxation methods of approximation. Convection phases of thermal circuits, free and forced, and ones involving vaporization and condensation. Heat radiation. Associated problems and laboratory work.

Texts: Jakob and Hawkins: Elements of Heat Transfer and Insulation; McAdams: Heat Transmission. W. H. Giedt: Principles of Engineering Heat Transfer.

Prerequisites: Ma-114(A) and ME-112(B).

ME-320(B) Heat Transfer 3-2

Basic concepts of heat transfer mechanisms are treated by classical boundary value problem techniques, numerical methods, analogue methods, "lumped parameter" and thermal circuit analyses and presentation and application of experimental data. Primary emphasis is upon conduction and convection for both steady state and un-steady state behavior.

Texts: W. H. Giedt: Principles of Engineering Heat Transfer; W. H. McAdams: Heat Transmission, 3rd Edition; M. Jakob: Heat Transfer, Volume I.

Prerequisites: Ma-114(A) and ME-112(B).

ME-350(B) Heat Transfer 2-2

General survey of the manners of energy transition by temperature potential, with major emphasis on its transfer by radiation and conduction under steady and unsteady-state conditions.

Texts: McAdams: Heat Transmission; Jakob: Heat Transfer, Vol. I; Jakob and Hawkins: Elements of Heat Transfer and Insulation.

Prerequisite. Ma-182(C).

ME-410(B) Hydromechanics 3-2

Brief coverage of hydrostatics, energy aspects of flow, momentum principle, and applications of dimensional analysis. Resistance to flow through and about bodies. Two dimensional potential flow theory and examples. Two dimensional viscous, incompressible fluid flow, with application to hydrodynamic lubrication. Associated laboratory exercises and problem work.

Texts: Departmental notes: Engineering Fluid Mechanics; Streeter: Fluid Dynamics.

Prerequisite: Ma-113(B).

ME-411(C) Hydromechanics 3-2

The mechanical properties of liquids, hydrostatic pressures and forces, buoyancy and ship stability. Energy aspects of fluid flow, fluid flow in pipes, flow metering and control. Dynamic forces associated with flow, impulse-momentum principles, analysis of hydro machinery. The principle of dynamic similarity and the techniques of dimensional analysis are developed and extensively used in analyses of lift and drag, performance of propellers, pumps, turbines, hydraulic couplings, etc. Elementary vortex flows; rotation and circulation introduced. Associated laboratory experiments and problem work. The course is the first of a sequence ME-411 and ME-412.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisite: Ma-113(B).

ME-412(A) Hydromechanics 4-2

Continuation of ME-411. Basic concepts of kinematics of ideal, incompressible fluids. Stream and velocity potential functions, elementary flow patterns and the synthesis of combined flows, graphically and mathematically. Basic concepts in vector notation, use of the complex variable leading to the theory and application of conformal transformations. Kutta-Joukowski and Blasius theorems. Theory of hydrodynamic lubrication.

Texts: Departmental notes: Engineering Fluid Mechanics; Streeter: Fluid Dynamics.

Prerequisites: ME-411(C) and Ma-114(A).

ME-421(C) Hydromechanics 3-2

The course is the first of a sequence of ME-421 and ME-422. The content parallels that of ME-411, but proceeds at a slower rate.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisite: Ma-111(C).

ME-422(B) Hydromechanics 2-2

Dynamic forces in fluid flow, centrifugal pumps, couplings and torque converters, jet propulsion. Introduction to the kinematics of idcal-fluid flow, primary flow patterns and their synthesis by graphical technics. Elements of hydrodynamic lubrication.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisites: Ma-113(B) and ME-421(C).

ME-441(B) Hydromechanics 4-2

A one-term coverage of ME-411 plus selected portions of ME-412 as follows: Introduction to the stream function, velocity potential, source, sink and potential vortex and their synthesis to form simple irrotational flow patterns. Brief survey of the utilization of vector calculus and the complex variable in analysis of more complex patterns.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisite. Ma-114(A).

ME-442(B) Compressible-fluid Flow 2-2

Review of general thermodynamic principles, and of the thermodynamic properties and property relation for gaseous fluids. Thermodynamics of the subsonic and supersonic flow of compressible fluids, reversible and shockwise, in nozzle or diffuser and about simpler obstructions. Associated wall forces, and their operation in jet propulsion and the rocket motor.

Text and Supplement: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Kaye: Gas Tables.

Prerequisites: Ch-401(A) and Ch-631(A).

ME-500(C) Strength of Materials 3-0

Elements of the mechanics of elastic bodies; tensile and compressive stresses, shearing stress, Hooke's law, thin-walled cylinders, combined stresses, torsion of circular-sectioned members, elementary beam theory, combined loadings and columns.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisites: Ma-111(C) and Mc-101(C).

ME-511(C) Strength of Materials 5-0

Topics in elastic-body mechanics, including tensile and compressive stress, shearing stress, Hooke's law, thin-walled cylinders, combined stresses, torsion of circular-sectioned members, elementary beam theory, statically indeterminate problems in bending, combined loading, columns, and beams on elastic foundations.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisites: Ma-111(C) and Mc-101(C).

ME-512(A) Strength of Materials 5-0

Beam columns, strain energy, shear center, thin plates, buckling of bars and plates, problems having radial symmetry, behavior beyond the elastic limit.

Text: Timoshenko: Strength of Materials, Vols. I and II.

Prerequisite: ME-511(C).

ME-513(A) Theory of Elasticity 3-0

Plane-stress considerations, differential equations of equilibrium and compatibility, the Airy stress function, curvilinear coordinates, problems in plane stress and plane strain, three-dimensional stress systems, St.-Venant theory of torsion, energy methods.

Text: Timoshenko and Goodier: Theory of Elasticity.

Prerequisite: ME-512(A).

ME-522(B) Strength of Materials 4-0

Beam columns, strain energy, shear center, thick cylinders, rotating disks, torsion of non-circular sections.

Text: Seeley and Smith: Advanced Mechanics of Materials.

Prerequisite: ME-511(C).

ME-541(C) Strength of Materials 3-0

Stress, strain, Hooke's law, thin-walled cylinders, combined stresses, torsion of solid and hollow shafts, elementary beam theory, combined bending and torsion, combined bending and axial load, behavior of columns.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisites: Ma-111(C) and Mc-101(C).

ME-542(B) Strength of Materials 3-0

Statically indeterminate problems in bending, bending beyond the yield point, curved beams, strain energy, mechanical properties of materials.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisite: ME-541(C).

ME-550(B) Elements of Dynamic Structural Analysis 5-0

Elastic and plastic analysis of structural elements. Structural types and nomenclature. Elastic and plastic analysis of statically determinate and indeterminate structures. Behavior of materials under suddenly applied loads. Engineering idealizations of loads imposed by blasts. Exact solutions for dynamic response of simple elements to suddenly applied loads. Introduction to the general problem of dynamic analysis of structures, through elastic and plastic phases. Numerical analysis of simple cases.

Texts: Timoshenko and MacCullough: Elements of Strength of Materials; Atomic Energy Commission: The Effects of Atomic Weapons; current reports.

Prerequisites: Mc-311(A) and ME-500(C).

ME-601(C) Materials Testing Laboratory 0-2

Performance and analysis of standard tests used in determining the mechanical properties of engineering materials, including tests in tension, compression, torsion, shear, transverse bending, impact and hardness.

Texts: Muhlenbruch: Testing of Engineering Materials; A.S.T.M. Student Standards.

Prerequisite: Subsequent to or concurrent with ME-500(C), ME-541(C), or Ae-211.

ME-611(C) Mechanical Properties of Engineering Materials 2-2

Study of the theories of failure, the evaluation of experimental error and experiments in the determination of the mechanical properties of engineering materials. These tests include: tension, compression, torsion, shear, transverse bending, impact, hardness, fatigue and column action.

Texts: Seely and Smith: Advanced Mechanics of Materials; Davis, et al: Testing and Inspection of Engineering Materials.

Prerequisite: ME-511(C).

ME-612(A) Experimental Stress Analysis 3-2

The course includes: dimensional analysis, strain gage techniques, photoelasticity, brittle lacquer method, membrane analogy, miscellaneous methods in experimental stress analysis. Diversified laboratory projects are assigned, offering an opportunity to apply the methods of experimental stress analysis to the solution of both static and dynamic problems.

Text: Lee: An Introduction to Experimental Stress Analysis.

Prerequisites: ME-513(A) and ME-611(C).

ME-622(B) Experimental Stress Analysis 2-2

Theory and application of the wire resistance strain gage for finding static and dynamic stresses in machines and structures. Brief survey of other techniques including brittle lacquer, photo-elasticity, and analog methods. Laboratory experiments cover both static and dynamic stress studies with the resistance gage and a variety of auxiliary instrumentation.

Text: Perry and Lissner: Strain Gage Primer.

Prequisites: ME-522(B) and ME-611(C).

ME-700(C) Kinematics of Machinery 3-2

This is a general service course. The following topics are studied: link-work, cams, toothed gearing, trains of mechanisms, velocities, accelerations, static forces and inertia forces on machine members. The practical work periods are devoted to the solution on the drawing board of selected problems

Text: Ham and Crane: Mechanics of Machinery.

Prerequisite: Mc-102(C).

ME-710(B) Mechanics of Machinery 4-2

Velocity and acceleration of machine parts, static and dynamic forces on machine members, kinematic analysis of cams and gears, balancing of solid rotors, basic vibration problems in machines.

Texts: Ham and Crane: Mechanics of Machinery; Thomson: Mechanical Vibrations.

Prerequisite: Mc-102(C).

ME-711(B) Mechanics of Machinery 4-2

Emphasis is placed on velocities and accelerations of machine parts. An analysis is made of static and inertia forces on machine members. Practical dynamic analysis of cams is included. The kinematics of gears are studied including spur, bevel, helical and worm gears. This course is the first of a coordinated sequence of ME-711 and ME-712.

Text: Ham and Crane: Mechanics of Machinery.

Prerequisite: Mc-102(C).

ME-712(A) Dynamics of Machinery 3-2

Studies are made of the following topics: Balancing of solid rotors and reciprocating machines, free and forced vibrations without and with damping for one, two or many degrees of freedom, vibration isolation, vibration absorbers, torsional vibration including the Holzer method, vibration of beams including Rayleigh's method for transverse vibrations, non-linear systems. Laboratory work includes the following experiments: balancing a solid rotor on a mechanical as well as an electrical balancing machine, rate of decay in the tranverse vibration of beams, calibration of velocity and acceleration pick-ups.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations.

Prerequisites: Ma-114(B), ME-711(B) and ME-511(C).

ME-713(A) Advanced Dynamics of Machinery 3-0

Several topics are studied from a theoretical as well as a practical point of view. These include: Shock and vibration mounts, torsional vibrations of crank shafts with emphasis on the design of tuned vibration absorbers, special bearings, gear tooth lubrication, sleeve bearings with pulsating loads, oil film whirl, turbine blade vibration, non-linear vibration problems, design and calibration of a velocity and an acceleration pick-up as carried out in the dynamics laboratory.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations; Karman and Biot: Mathematical Methods in Engineering.

Prerequisites: ME-712(A) and ME-312(B).

ME-730(A) Vibrations 3-2

Studies are made of the following topics: Balancing of solid rotors and reciprocating machines, free and forced vibrations without and with damping for one, two or many degrees of freedom, vibration isolation, vibration absorbers, torsional vibration including the Holzer method, vibration of beams including Rayleigh's method for transverse vibrations, non-linear systems. Laboratory work includes the following experiments: balancing a solid rotor on a mechanical as well as an electrical balancing machine, rate of decay in the transverse vibration of beams, calibration of velocity and acceleration pick-ups.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations.

Prerequisites: Ma-114(B), Mc-102(C), and ME-500(C).

ME-740(C) Kinematics and Machine Design 3-2

Studies are made of the following topics: displacements, velocities, and accelerations of the various kinematic linkages, such as the four bar mechanism, the drag link, cams, gears, intermittent motions, cyclic gears and gyros. Several design topics will be considered: the design of shafting (considering strength, deflection, bearing loads, critical speeds etc.); couplings; springs; bearings, fits and tolerances.

Texts: Ham and Crane: Mechanics of Machinery; Departmental notes.

Prerequisites: Mc-102(C) and ME-542(B).

ME-811(C) Machine Design 3-2

Review of strength of materials, selections of materials, stress-concentration, bearings, fits and tolerances. Several short design projects as follows: tabulation of tolerances for shafts and holes for the various classes of fits, accumulation of tolerances in machines, design of an armature shaft, spring design, screw fastening design, design of a power screw and the design of a set of gears. Studies of belt and chain drives, brakes, clutches, cams and thin and thick cylinders.

Text: Vallance and Doughtie: Design of Machine Members.

Prerequisites: ME-511(C) and ME-711(B).

ME-812(B) Machine Design 3-4

Several practical design projects will be completed on the drawing board. The projects will give the students an opportunity to combine theory with practice. The drawings involved in the projects will be completely dimensioned; proper materials selected; correct base references, surfaces for machining and inspecting will be chosen; proper fits and tolerances will be chosen for interchangeable manufacture. The objective is to create designs which may actually be fabricated.

Text: Departmental Notes.

Prerequisite: ME-811(C).

ME-820(C) Machine Design 2-4

Short review of strength of materials. Stress-concentration, factors of safety. Fits and tolerances. Several short design projects which illustrate the application of the principles of stress, strain, deflection, fits and tolerances, vibrations, etc. General design information on bearings, springs, shafting, screw fastenings, gears, clutches, brakes, cams and thick and thin cylinders.

Text: Departmental notes.

Reference: Vallance and Doughtie: Design of Machine Members.

Prerequisite: ME-700(C).

ME-830(C) Machine Design 4-2

Review of strength of materials, selections of materials for different designs. Stress-concentration, bearing design, fits and tolerances. Several short design projects as follows: tabulation of tolerances for shafts and holes for various classes of fits, accumulation of tolerances in machines, design of an armature shaft, spring design, screw fastening design, design of a power screw and the design of a set of gears. Studies of belt and chain drives, brakes, clutches, cams and thin and thick cylinder design.

Text: Vallance and Doughtie: Design of Machine Members.

Prerequisites: ME-700(C) and Ae-202(C).

ME-840(C) Manufacturing Engineering 3-2

The following topics are studied: the principles of interchangeable manufacture, the selection of and use of the proper machine tools to fulfill a specific requirement, the details of gage design and inspection methods with reference to proper fits and tolerances. Several industrial plants will be visited, where lectures on the use of machines will be provided.

Text: Buckingham: Interchangeable Manufacturing.

Prerequisite: ME-811(C).

ME-900(A) Special Problems in Mechanical Engineering 3-0

Advanced topics to meet special entrance requirements at other institutions. Analytic theory of heat conduction. Thermal stresses in plates, rods, and pressure vessels.

Texts: Jakob: Heat Transfer; Timoshenko and Goodier: Theory of Elasticity.

Prerequisites: ME-310(M) and ME-512(A) or equivalent.

METALLURGY

Mt Courses

Production Metallurgy ----------Mt-101(C)
Production of Steel ----------Mt-102(C)
Production of Non-Ferrous Metals ----------Mt-103(C)
Production Metallurgy ----------Mt-104(C)
Introductory Physical Metallurgy ----------Mt-201(C)
Ferrous Physical Metallurgy ----------Mt-202(C)
Physical Metallurgy (Special Topics) ----------Mt-203(B)
Non-Ferrous Metallography ----------Mt-204(A)
Advanced Physical Metallurgy ----------Mt-205(A)
Advanced Physical Metallurgy ----------Mt-206(A)
Physics of Solids ----------Mt-207(B)
Physical and Production Metallurgy ----------Mt-208(C)
High Temperature Materials ----------Mt-301(A)
Alloy Steels ----------Mt-302(A)
Metallurgy Seminar ----------Mt-303(A)
Radiography ----------Mt-304(C)
Physics of Metals ----------Mt-401(A)
Nuclear Reactor Materials
Effects of Radiation ----------Mt-402(B)
Welding Metallurgy ----------Mt-501(A)

Mt-101(C) Production Metallurgy 2-0

An introduction to the study of metallurgy and is essentially descriptive in nature. Subjects treated include the occurrence and classification of metal-bearing raw materials; the fundamental processes of extractive metallurgy; refractories, fuels, fluxes, slags and equipment; a brief summary of steel-making and the production of copper and zinc.

Text: Stoughton, Butt: Engineering Metallurgy (1938).

Prerequisite: Ch-101(C) or Ch-121(B), or concurrently with either.

Mt-102(C) Production of Steel 3-0

The subject matter includes such topics as the occurrence and composition of various iron ores, blast furnace products. The various methods of steel production and the production of grey, white and malleable cast iron.

Text: Bray: Ferrous Production Metallurgy.

Prerequisite: Ch-101(C) or Ch-121(B).

Mt-103(C) Production of Non-Ferrous Metals 3-0

A discussion of the sources, the strategic importance of, and the methods of production of the following metals: copper, zinc, lead, tin, aluminum, magnesium, and other metals of technical interest.

Text: Bray: Non-Ferrous Production Metallurgy.

Prerequisite: Ch-101(C) or Ch-121(B).

Mt-104(C) Production Metallurgy 4-0

An introduction to the study of production metallurgy. Subjects treated include the occurrence of metal bearing raw materials, the fundamental processes of extractive metallurgy, refractories, fuels, fluxes. Production of steel, cast iron, copper, zinc, lead, tin, nickel, aluminum and magnesium.

Text: Bray: Ferrous Production Metallurgy;
Bray: Non-Ferrous Production Metallurgy.

Prerequisite: Ch-101(C) or equivalent.

Mt-201(C) Introductory Physical Metallurgy 3-2

An introduction to physical metallurgy. Subjects treated include: (a) the nature, characteristics and properties of metals; (b) the application of the phase rule to binary and ternary alloy systems and characteristic phase diagrams; (c) the correlation of microstructure, mechanical properties and corrosion resistance of alloys, with phase diagrams; (d) mechanical deformation and heat treatment of alloys; (e) descriptions of representative non-ferrous alloys of commercial importance. The subject matter is illustrated by reference to technically important alloy systems in which the phenomena are commonly observed.

The laboratory experiments are designed to introduce to the student the methods available to the metallurgist for the study of metals and alloys. These include the construction of equilibrium diagrams and metallographic studies of fundamental structures, brass, bronze, bearings, etc.

Texts: Coonan: Principles of Physical Metallurgy; Clark and Varney: Physical Metallurgy for Engineers.

Prerequisite: None.

Mt-202(C) Ferrous Physical Metallurgy 3-2

Continues the presentation of subject matter introduced in Metals, Mt-201, with emphasis on the alloys of iron. Subjects treated include (a) the iron-carbon alloys, (b) effects of various heat treatments and cooling rates on the structure and properties of steel, (c) isothermal reaction rates and the hardenability of steel, (d) surface hardening methods, (e) characteristics and properties of plain carbon and alloy cast irons, (f) the effect of other alloying elements on steel, (g) tool steels.

The laboratory work includes experiments in the heat treatment of steel, mechanical testing and metallographic examination of common ferrous alloys.

Texts: Coonan: Principles of Physical Metallurgy; Clark and Varney: Physical Metallurgy for Engineers.

Prerequisite: Mt-201(C).

Mt-203(B) Physical Metallurgy (Special Topics) 2-2

A continuation of material presented in Mt-201 and Mt-202. The subject matter includes a discussion of the theories of corrosion, factors in corrosion, corrosion prevention, corrosion resistant metals and alloys, powder metallurgy, metallurgical aspects of welding and casting, fatigue and fatigue failures, creep of metals, properties of metals at low temperatures, and surveys of the alloys of aluminum and magnesium and of certain alloys having characteristics suitable for special applications.

Texts: Coonan: Principles of Physical Metallurgy; Heyer: Engineering Physical Metallurgy; Woldman: Metal Process Engineering; Clark and Varney: Physical Metallurgy for Engineers; Reynolds Metals Company: Aluminum Heat Treating.

Prerequisite: Mt-202(C).

Mt-204(A) Non-Ferrous Metallography 3-3

An expansion of material introduced in Mt-201, Mt-202 and Mt-203 with greater emphasis on the intrinsic properties of specific nonferrous metals and alloys. Metals and alloys of importance in engineering and technical applications are discussed in considerable detail with respect to their physical and mechanical properties, microstructures, response to mechanical deformation and heat treatment, advantages and disadvantages for technical applications and unique characteristics leading to specific applications.

Text: None

Prerequisites: Mt-201(C) and Mt-202(C).

Mt-205(A) Advanced Physical Metallurgy 3-4

The subject matter includes a discussion of equilibrium in alloy systems, structure of metals and alloys, phase transformations and diffusion.

Texts: Barrett: Structure of Metals; Rhines: Phase Diagrams in Metallurgy; Smoluchowski: Phase Transformations in Solids.

Prerequisite: Mt-202(C).

Mt-206(A) Advanced Physical Metallurgy 3-4

The subject matter is an extension of that offered in Mt-205(A) and includes such topics as plastic deformation, theories of slip, recrystallization, preferred orientation, age hardening, etc.

Texts: Barrett: Structures of Metals; Chalmers: Progress in Metal Physics; Cottrell: Dislocations and Plastic Flow in Crystals; Shockley: Imperfections in Nearly Perfect Crystals.

Prerequisite: Mt-205(A).

Mt-207(B) Physics of Solids 3-0

A course for engineers intended as an introduction to the physics of solids. Topics discussed include introductory statistical mechanics, atomic structure and spectra, introductory quantum mechanics, binding and energy bands, crystal structure, and imperfections in crystals.

Text: Sproull: Modern Physics.

Prerequisite: Mt-202(C).

Mt-208(C) Physical and Production Metallurgy 4-2

This course covers the same material as Mt-202 and includes in addition the production of iron and steel. One period each week is devoted to this latter topic.

Texts: Coonan: Principles of Physical Metallurgy; Clark and Varney: Physical Metallurgy for Engineers;Stoughton and Butts: Engineering Metallurgy.

Prerequisite: Mt-201(C).

Mt-301(A) High Temperature Materials 3-0

A study of the effect of high temperature on the properties of metals. Methods of evaluating behavior of materials at elevated temperatures. Factors in the selection of materials for elevated temperatures. Development of alloys for high temperature service. Refractory metals, super alloys, alloys of titanium and molybdenum. Creep and allied phenomena. Metals used in gas turbines, reaction motors, etc. Use of ceramics, development of cermets.

Text: Coonan: High Temperature Materials.

Prerequisite: Mt-202(C).

Mt-302(A) Alloy Steels 3-3

The subject matter covered includes a thorough study of the effects of the alloying elements, including carbon, commonly used in steel making on the characteristics of steels in the annealed, the hardened and the hardened and tempered conditions. The principles elucidated are subsequently applied to studies of the classes of steels used for structural purposes, machinery (S.A.E. and A.I.S.I. grades), electrical purposes, tools, and corrosion resisting purposes.

Text: E. C. Bain: The Alloying Elements in Steel; references and reading assignments in other books and current literature.

Prerequisite: Mt-202(C).

Mt-303(A) Metallurgy Seminar Hours to be arranged

Papers from current technical journals will be reported on and discussed by students.

Text: None.

Prerequisite: Mt-203(B) or 205(A).

Mt-304(C) Radiography 2-2

Principles of x-ray and gamma ray radiography, including a discussion of high voltage equipment, film characteristics and a comparison of radiography with other non-destructive methods of inspection.

Text: None.

Prerequisite: Mt-202(C).

Mt-401(A) Physics of Metals 3-0

A discussion of crystal chemistry and modern theories of the solid state. Topics considered are the wave nature of electrons, the electron theory of metals, reaction kinetics, free energy of alloy phases, order-disorder transformations, etc.

Texts: Cottrell: Theoretical Structure Metallurgy; Kittell: Solid State Physics; selected references.

Prerequisites: Mt-205(A) and either Ph-610(B) or Ph-640(B).

Mt-402(B) Nuclear Reactor Materials—Effects of Radiation 4-0

A course designed for students in nuclear engineering. Includes a study of materials of reactor construction; factors in materials selection; commercially available materials; liquid metal coolants; nature of radiation damage on materials.

Texts: The Reactor Handbook—General Properties Materials; Finniston and Howe: Metallurgy and Fuels.

Prerequisite: Mt-202(C), Mt-207(B), or equivalent.

Mt-501(A) Welding Metallurgy 3-3

This course is designed to study in considerable detail the various materials, equipment, and processes employed for joining metals by both the plastic and the fusion welding methods, and to correlate the mechanical, electrical, and metallurgical factors essential to successful welding. Topics covered include heat sources, welding machines, manual and automatic processes, fluxes and slags, evaluation of materials, examination and testing of welded structures, metallurgy of weld deposits and heat-affected parent metals, weldability, underwater welding and cutting, corrosion of welds and welded structures, and the origin and control of defects in welding.

The laboratory exercises are designed to familiarize the student with the more common welding processes and to permit verification of certain aspects of the subject matter.

Texts: None. References from handbooks, periodicals and manufacturers' literature.

Prerequisite: Mt-203(B).

OCEANOGRAPHY

Oc Courses

Survey of Oceanography ----------Oc-100(C)
Introduction to Oceanography ----------Oc-110(C)
General Oceanography ----------Oc-120(B)
Physical Oceanography ----------Oc-210(B)
Tides and Tidal Currents ----------Oc-212(B)
Shallow-Water Oceanography ----------Oc-213(B)
Ocean Currents and Diffusion ----------Oc-220(B)
Submarine Geology ----------Oc-310(B)
Marine Biology ----------Oc-410(B)
Chemical Oceanography ----------Oc-510(B)
Naval Applications of Oceanography ----Oc-610(B)
Oceanographic Factors in Underwater Sound ----------Oc-620(B)
Oceanography of Mine Warfare I ----------Oc-631(A)
Oceanography of Mine Warfare II ----------Oc-632(A)
Engineering Aspects of Oceanography ---Oc-640(A)

Oc-100(C) Survey of Oceanography 3-0

A descriptive course, complete in itself, suitable for all curricula. Similar to Oc-110(C), but emphasizing physical, chemical, biological, geological, and meteorological problems that the marine environment presents to naval operations.

Texts: Sverdrup: Oceanography for Meteorologists; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisite: None.

Oc-110(C) Introduction to Oceanography 3-0

A descriptive course which provides background for later courses in oceanography; it may be taken by students in all curricula. Topics include the physical and chemical properties of sea water, marine biology, and submarine geology; the heat budget of the oceans; water masses and the general circulation; currents, waves, and tides.

Texts: Sverdrup: Oceanography for Meteorologists; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisite: None.

Oc-120(B) General Oceanography 4-0

Similar to Oc-110(C) but with emphasis on the meteorological aspects of oceanography, including the exchange of heat, moisture, and momentum between the sea and atmosphere, the relation of these exchanges to the changes in the vertical thermal structure of the sea, and the characteristics of ocean waves.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisite: Ph-196(C) or equivalent.

Oc-210(B) Physical Oceanography 2-1

Processes which tend to modify the distribution of the physical properties in the oceans; vertical thermal structure in the surface layers; equations of motion; advection and diffusion; mass-distribution and wind-driven currents; characteristics of surface and internal waves; tidal phenomena.

Texts: Sverdrup: Oceanography for Meteorologists; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; departmental notes.

Prerequisites: Oc-110(C) or equivalent, Ma-163(C) or equivalent, and Ph-198(C).

Oc-212(B) Tides and Tidal Currents 3-0

Theories of the astronomical tides; the tide-producing forces; tidal oscillations in ocean basins; geographical variation of the tides; analysis and prediction of tides; tidal datum planes. Meteorological tides. Seiches. Tidal currents.

Texts: Marmer: The Tide; Marmer: Tidal Datum Planes.

Prerequisites: Ma-111(C) and Ph-142(B) or their equivalents.

Oc-213(B) Shallow-Water Oceanography 3-0

Types and characteristics of continental shelves, coasts, and beaches; surf, breaking waves, littoral currents, and other shallow-water phenomena, and their influence upon amphibious operations; estuarine and harbor circulation.

Text: Departmental notes.

Prerequisites: Oc-110(C) or equivalent, and Mr-610(B).

Oc-220(B) Ocean Currents and Diffusion 2-0

Physical processes in the oceans, with emphasis on the advection and diffusion of radioactive wastes in the sea, and the natural flushing of contaminants from harbors and estuaries. Especially suitable for the Nuclear Engineering Curriculum.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisites: Ma-381(C) or equivalent, and Oc-110(C) or equivalent.

Oc-310(B) Submarine Geology 3-0

General physiography of the ocean basins; topographic features of the sea floor, especially seamounts, the continental slope and shelf, submarine canyons, and coral reefs; marine processes that have shaped the ocean basins and coasts; character of marine sediments; geographical and vertical distribution of sediment types; rates of deposition; origin of the ocean basins. Summary of the influence of of the sea floor on naval problems.

Text: Shepard: Submarine Geology.

Prerequisite: Oc-110(C) or equivalent. Ge-101(C) is desirable but not necessary.

Oc-410(B) Marine Biology 3-1

Plant and animal groups in the oceans; marine biological environments; character of the plankton, nekton, and benthos; ecology of marine organisms; oceanographic factors influencing populations and the effect of organisms on the physical-chemical properties of sea water; bioluminescence. Summary of the influence of marine biology on naval problems, including a study of those organisms responsible for boring, fouling, sound and light production, and sound scattering.

Text: Sverdrup, Johnson, and Fleming: The Oceans.

Prerequisite: Oc-110(C) or equivalent.

Oc-510(B) Chemical Oceanography 3-2

Chemical composition of sea water; total salinity and density; dissolved gases with emphasis on the carbon-dioxide system; plant nutrients; organic and inorganic agencies affecting the composition; the observed distribution of salts, dissolved gases, and nutrients; sea ice; geochemistry of the oceans. Summary of the Navy's problems in chemical oceanography, including corrosion and the production of fresh water from sea water. The laboratory includes chemical determination of the salinity and oxygen content of sea-water samples, and sea-water density computations.

Texts: Harvey: Recent Advances in the Biological Chemistry and Physics of Sea Water; Sverdrup, Johnson, and Fleming: The Oceans.

Prerequisites: Ch-101(C) or equivalent, and Oc-110(C) or equivalent.

Oc-610(B) Naval Applications of Oceanography 3-0

The applications of oceanography to navigation, submarine warfare, mine warfare, amphibious, carrier, and sea-plane operations, survival and rescue at sea, etc.

Texts: NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; selected publications.

Prerequisite: Oc-110(C) or equivalent.

Oc-620(B) Oceanographic Factors in Underwater Sound 3-0

The oceanographic factors involved in sound ranging, including thermal gradients, sound absorption properties of sea water, sound scattering and reflection characteristics of the sea surface and sea floor, scattering properties of marine organisms, and ambient noise arising in the sea. Forecasts are made of the vertical thermal structure in the surface layers.

Texts: NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; departmental notes.

Prerequisites: Oc-110(C) or equivalent and Ph-196(C) or equivalent.

Oc-631(A) Oceanography of Mine Warfare I 3-0

The mechanics of simple water waves, ocean-wave spectra, statistical properties of ocean waves, wave forces, and wave pressures; the movement of ships in irregular seas; tides, tidal currents, and the forces associated with them; sea-water transparency and underwater visibility.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; H.O. 603: Practical Methods for Observing and Forecasting Ocean Waves; departmental notes.

Prerequisites: Oc-110(C), Ma-112(B), and Ma-381(C).

Oc-632(A) Oceanography of Mine Warfare II 3-0

Physical and engineering properties of marine sediments, load-bearing capacity of sediments; deposition and erosion on the ocean floor, current scour around objects on the bottom; geographical distribution of marine sediments; acoustical and electrical characteristics of sediments; biological fouling organisms, distribution of foulers, rates of fouling; sources of oceanographic data.

Texts: Terzaghi and Peck: Soil Mechanics in Engineering Practice; Shepard: Submarine Geology; United States Naval Institute: Marine Fouling and its Prevention.

Prerequisite: Oc-110(C).

Oc-640(A) Engineering Aspects of Oceanography 3-0

Engineering application of oceanographic information, including the motion of ships in a seaway; the effect of harbor surging on moored ships; wave forces on breakwaters, pilings, mines, etc; permanent and mobile breakwaters; the influence of piers, breakwaters, and seawalls on coastline erosion; shoreline protection from marine erosion; harbor design and maintenance; and hydraulic models.

Texts: Departmental notes and selected publications.

Prerequisites: Oc-210(B) and Mr-610(B).

OPERATIONS ANALYSIS

Oa Courses

Survey of Operations Analysis ----------Oa-121(C)
Survey of Weapons Evaluation ----------Oa-151(B)
Measures of Effectiveness of Mines ------Oa-152(C)
Game Theory and Its Applications to Mine Fields ----------Oa-153(B)
Operations Analysis for Navy Management ----------Oa-171(C)
Introduction to Operations Analysis -----Oa-191(C)
Operational Analysis ----------Oa-192(B)
Effectiveness of Weapons ----------Oa-193(B)
Optimal Weapon Systems I ---------- Oa-194(A)
Optimal Weapon Systems II ----------Oa-195(A)
Logistics Analysis ----------Oa-201(A)
Econometrics ----------Oa-202(A)
Theory of Information Communication ----------Oa-401(A)
Seminar in Operations Analysis ---------Oa-891(A)

Oa-121(B) Survey of Operations Analysis 3-0

The nature, origin, and contemporary status of operations analysis; fundamental concepts with special emphasis on applications in the field of evaluating radar and sonar; introduction to game theory, linear programming, and other advanced techniques.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; classified official publications; notes from MIT Summer Course on Operations Research, 1953; McClosky and Trefethen: Operations Research for Management, Vols. I and II.

Prerequisite: Ma-321(B).

Oa-151(B) Survey of Weapons Evaluation 3-0

Review of probability theory with military interpretations. Sources of firing errors and their relative contributions to the over-all errors. Damage probabilities. Selection of optimal weapon systems. Introduction to game theory.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; classified official publications.

Prerequisites: Ma-113(B) and Ma-301(B).

Oa-152(C) Measures of Effectiveness of Mines 3-0

Review of probability theory with military interpretations. Introduction to operations analysis. Errors in mine laying. Probability of damage. Theory of mine field operation.

Texts: Classified official publications.

Prerequisite: Ma-381(C).

Oa-153(B) Game Theory and Its Applications to Mine Fields 3-0

A continuation of Oa-152(C). Introduction to game theory. Operation of a mine field according to game theory. Analysis of countermeasures.

Texts: Classified official publications.

Prerequisite: Oa-152(C).

Oa-171(C) Operations Analysis for Navy Management 3-0

The nature, origin and contemporary status of operations analysis; fundamental concepts with special emphasis on applications in the fields of transportation, inventory control and personnel management. Introduction to game theory, linear programming and queueing theory.

Texts: McClosky and Trefethen: Operations Research for Management, Vols. I and II; Notes from MIT Summer Course on Operations Research, 1953; Koopmans: Activity Analysis of Production and Allocation; Instructor's Notes.

Prerequisite: Ma-371(C).

Oa-191(C) Introduction to Operations Analysis 3-0

Development of fundamental concepts and methods of operations analysis as illustrated in the fields of submarine and anti-submarine warfare. Over-all measures of effectiveness of a submarine as a weapon system. Determination of effectiveness as a product of measures of detection, attack, and kill capabilities.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; classified official publications; McClosky and Trefethen: Operations Research for Management, Vols. I and II; Tucker: Submarine Firing Phase Decisions, USNPS Thesis.

Prerequisites: Ma-182(C) and Ma-381(C).

Oa-192(B) Operational Analysis (Selected Topics) 4-0

Theory of search. Evaluation of the operational performance of search radars. Search patterns and barrier patrols. Application of operational analysis to the problems of fleet air defense. Special weapons. The effects of system complexity on system reliability.

Text: Classified Official Publications.

Prerequisite: Oa-191(C).

Oa-193(B) Weapon Systems 4-0

The probability of a hit on an evading target. Correlation between shots. The appraisal of weapon systems; selection of optimal weapon systems. Input-output analysis of a minefield.

Texts: Classified official publications.

Prerequisites: Ma-392(C) and Oa-191(C).

Oa-194(A) Optimal Weapon Systems I 4-0

The appraisal of weapon systems. Selection of optimum airplane weapon system for anti-submarine patrol. Selection of optimum airplane weapon system for mine-laying. The selection and optimal use of psychological and other weapons.

Texts: Classified official publications.

Prerequisites: Ma-501(A) and Oa-193(B).

Oa-195(A) Optimal Weapon Systems II 3-0

Evaluation of fleet air defense. Applications of operations analysis to the problem of continental air defense. Special weapons. The effects of system complexity on system reliability.

Texts: Classified official publications.

Prerequisite: Oa-194(A).

Oa-201(A) Logistics Analysis 3-2

Mathematical methods in logistics, with major emphasis on applications of linear programming to problems of transportation and scheduling of interdependent activities. Theory of inventory control. Dynamic programming. Laboratory work on computation of optimal solutions of linear programs.

Texts: Koopmans: Activity Analysis of Production and Allocation; Project RAND Paper P-189, Optimal Inventory Policy; Project RAND Report R-245, An Introduction to the Theory of Dynamic Programming.

Prerequisites: Ma-501(A) and Ma-195(A).

Oa-202(A) Econometrics 3-0

A continuation of Oa-201(A). Inter-industry analysis; mathematical economic theory; review of current theoretical investigations of relationships between military programs and the national economy.

Texts: Koopmans: Activity Analysis of Production and Allocation; Project RAND Report R-245, An Introduction to the Theory of Dynamic Programming; Morgenstern: Economic Activity Analysis; Conolly: Interdiction Considerations in Leontieff—Type Models of Land Logistic Networks, USNPS Thesis.

Prerequisites: Oa-201(A) and Ma-195(A).

Oa-401(A) Theory of Information Communication 3-0

Markov chains; surprisal of events and uncertainty of distributions; characterization of uncertainty; noise and rate of information transmission; limit distributions connected with sequences from an ergodic Markov chain; Shannon-Fano coding; detection.

Texts: Shannon and Weaver: The Mathematical Theory of Communication; S. Goldman: Information Theory; P. M. Woodward: Probability and Information Theory with Applications to Radar; R. M. Fano; The Transmission of Information, MIT Technical Reports 65 and 149.

Prerequisites: Ma-195(A) and Ma-383(A).

Oa-891(A) Seminar in Operations Analysis 2-4

Opportunity is given to students to prepare original material, or to choose current publications for study, and to present reports of this work as a phase of Operations Analysis.

Text: None.

Prerequisite: A background of advanced work in Operations Analysis.

ORDNANCE

Or Courses

Ordnance I ----------Or-101(C)
Ordnance II ----------Or-102(C)
Ordnance III ----------Or-103(C)
Ordnance IV ----------Or-104(C)
Mines and Mine Mechanisms ----------Or-191(C)
Mining Operations ----------Or-192(C)
Guided Missiles I ----------Or-241(C)
Guided Missiles II ----------Or-242(B)
Mine Countermeasures I ----------Or-291(C)
Mine Countermeasures II ----------Or-292(C)
Mine Warfare Seminar ----------Or-294(A)

Or-101(C) Ordnance I 2-1

The first of four courses in a series designed to provide a survey of the organization, principles, and theories used in the various ordnance fields with limited examples to demonstrate application. Bureau of Ordnance organization and activities; logistics; safety precautions; explosives; ammunition selection and capabilities; ordnance literature.

Text: Classified official publications.

Prerequisite: None.

Or-102(C) Ordnance II 3-2

Continuation of Or-101(C) series. Basic mechanisms (mechanical, electrical, and electronic); gyros; aviation ordnance; guided missiles; underwater ordnance.

Text: Classified official publications.

Prerequisite: None.

Or-103(C) Ordnance III 2-2

Continuation of Or-101(C) series. A study of the surface and AA fire control theories and fundamentals. Fire control radar; comparison of fundamentals of AA fire control systems; dynamics of fire control systems; theory of lead computing gunsights.

Texts: Classified official publications.

Prerequisite: None.

Or-104(C) Ordnance IV 2-1

Continuation of Or-101(C) series. Chemical warfare, agents, effects, methods; biological warfare, agents, methods; atomic warfare, nuclear reactions, effects, damage criteria and weapons size.

Text: Classified official publications.

Prerequisite: None.

Or-191(C) Mines and Mine Mechanisms 2-0

Present U. S. mines, mine handling, mine storage, explosives, surveillance. Foreign types. Mine firing mechanisms, representative types. Preparation and test.

Text: Classified official publications.

Prerequisite: None.

Or-192(C) Mining Operations 2-0

Mine layers. Tactical and strategic mining. Mine fields. Minelaying plans. Procedures. Requirements. Operation plans.

Text: Classified official publications.

Prerequisite: Or-191(C).

Or-193(C) Mines and Mining Operations 2-2

A combination presentation of the material in Or-191(C) and Or-192(C).

Text: Classified official publications.

Prerequisite: None.

Or-241(C) Guided Missiles I 2-0

General concepts and theoretical problems involved in guidance, launching, propulsion, warhead design, stabilization, and simulation of guided missiles. Tactical problems and limitations of guidance systems. Organization of guided missile program. Test ranges and instrumentation. Practical application as exemplified by the BAT.

Text: Classified official publications.

Prerequisite: None.

Or-242(B) Guided Missiles II 2-0

Continuation of Or-241(C). Concepts of FM-CW and doppler radar; types of servos; the ballistic trajectory as applied to guided missiles. Application of guided missiles principles and uses as exemplified by V-2, Loon, Terrier, Talos, Zeus, and Regulus. The Kingfisher-Petrel program.

Text: Classified official publications.

Prerequisite: Or-241(C).

Or-291(C) Mine Countermeasures I 3-0

Sweeper characteristics. Sweeping techniques. Countermeasures for specific influence mine types. Practical sweeping of influence mines. Passive countermeasures.

Text: Classified official publications.

Prerequisite: None.

Or-292(C) Mine Countermeasures II 3-2

Continuation of Or-291(C). Theory of various countermeasures techniques. Mine detection by various means. Scope of detection devices. Mine destruction. Operation plans, and procedures. During Lab periods students present reports on current Mine Warfare publications.

Text: Classified official publications.

Prerequisite: Or-291(C).

Or-294(A) Mine Warfare Seminar 2-0

Investigation and reports by students on assigned mine warfare topics. Occasional presentations and discussions by field representatives of mine warfare activities.

Text: None.

Prerequisite: Or-292(C).

PHYSICS

Ph Courses

Dynamics ---------- Ph-113(B)
Analytical Mechanics ---------- Ph-141(B)
Analytical Mechanics ---------- Ph-142(B)
Analytical Mechanics ---------- Ph-144(A)
Hydrodynamics ---------- Ph161(A)
Survey of Physics I ---------- Ph-190(C)
Survey of Physics II ---------- Ph-191(C)
Review of General Physics ---------- Ph-196(C)
Review of Physics I ---------- Ph-197(C)
Review of Physics II ---------- Ph-198(C)
Optics and Spectra ---------- Ph-240(C)
Radiation ---------- Ph-241(C)
Electrostatics and Magnetostatics ---------- Ph-311(B)
Applied Electromagnetics ---------- Ph-312(A)
Electricity and Magnetism ---------- Ph-341(C)
Electromagnetism ---------- Ph-361(A)
Electromagnetic Waves ---------- Ph-362(A)
Fundamental Acoustics ---------- Ph-421(B)
Underwater Acoustics ---------- Ph-425(A)
Acoustics Laboratory ---------- Ph-426(B)
Fundamental Acoustics ---------- Ph-427(B)
Underwater Acoustics and Sonar Systems ---------- Ph-428(A)
Fundamental Acoustics ---------- Ph-431(B)
Underwater Acoustics and Sonar Systems ---------- Ph-432(A)
Propagation of Waves in Fluids ---------- Ph-433(A)
Shock Waves in Fluids ---------- Ph-441(A)
Shock Waves in Fluids ---------- Ph-442(A)
Underwater Acoustics ---------- Ph-450(B)
Transducer Theory and Design ---------- Ph-461(A)
Acoustics Research ---------- Ph-471(A)
Thermodynamics ---------- Ph-530(B)
Kinetic Theory and Statistical Mechanics ---------- Ph-540(B)
Kinetic Theory and Statistical Mechanics ---------- Ph-541(B)
Survey of Thermodynamics and Statistical Mechanics ---------- Ph-542(B)
Survey of Atomic and Nuclear Physics ---------- Ph-610(B)
Atomic Physics ---------- Ph-620(B)
Atomic Physics ---------- Ph-631(B)
Atomic Physics ---------- Ph-640(B)
Atomic Physics Laboratory ---------- Ph-641(B)
Nuclear Physics ---------- Ph-642(B)
Nuclear Physics Laboratory ---------- Ph-643(B)
Advanced Nuclear Physics ---------- Ph-644(A)
Advanced Nuclear Physics Laboratory ---------- Ph-645(A)
Nuclear Instrumentation ---------- Ph-650(A)
Reactor Theory ---------- Ph-651(A)
Physics of the Solid State ---------- Ph-710(B)
Introductory Quantum Mechanics ---------- Ph-720(A)
Introductory Quantum Mechanics ---------- Ph-721(A)
Physics of the Solid State ---------- Ph-723(A)
Physics of the Solid State ---------- Ph-730(A)
Theoretical Physics ---------- Ph-731(A)
Physics Seminar ---------- Ph-750(A)

Ph-113(B) Dynamics 3-0

Fundamental dynamical concepts, oscillator theory, motion of a particle in two and three dimensions, motion in central fields with emphasis on atomic structure, motion of a system of particles, center of mass coordinates, wave motion, Lagrange's and Hamilton's methods.

Texts: Symon: Mechanics; Page: Introduction to Theoretical Physics.

Prerequisite: None.

Ph-141(B) Analytical Mechanics 4-0

Fundamental dynamical concepts, oscillator theory, curvilinear motion in a plane, energy concepts, statics and dynamics of a rigid body. Both analytical and vector methods are used.

Texts: Symon: Mechanics; Page: Introduction to Theoretical Physics.

Prerequisite: Ma-182(C). (May be taken concurrently.)

Ph-142(B) Analytical Mechanics 4-0

Wave motion, fluid mechanics, constrained motion, Hamilton's principle, Lagrange's equations.

Texts: Symon: Mechanics; Page: Introduction to Theoretical Physics.

Prerequisites: Ma-183(B) (may be taken concurrently) and Ph-141(B).

Ph-144(A) Analytical Mechanics 4-0

The linear oscillator, central force motion, Lagrange's and Hamilton's equations. Kinematics of rigid bodies. Canonical transformations. Coupled systems and normal coordinates.

Text: Goldstein: Classical Mechanics; lecture notes.

Prerequisite: Ph-142(B) or equivalent.

Ph-161(A) Hydrodynamics 3-0

Equilibrium conditions for liquids; liquids under gravity and coriolis forces; Eulerian and Lagrangean motion; Bernoulli equation; two-dimen-

sional flow, Schwarz-Christoffel transformations; three-dimensional flow; vorticity, viscous flow; analogue to magnetic-statics; hydrofoils; surface waves.

Texts: Streeter: Fluid Dynamics; Lecture Notes.

Prerequisites: Ae-100(C); Ae-121(C); Ma-114(A).

Ph-190(C) Survey of Physics I 3-0

Elementary concepts and laws of statics and dynamics. Introduction to the statics and dynamics of fluids. Temperature, heat, radiation, kinetic theory and the gas laws. Fundamentals of vector representation and notation.

Text: Sears and Zemansky: College Physics.

Prerequisite: None.

Ph-191(C) Survey of Physics II 3-0

A continuation of Ph-190(C). A survey of wave propagation, sound, electricity and magnetism, atomic structure, the properties of light, and other electromagnetic wave phenomena.

Text: Sears and Zemansky: College Physics.

Prerequisite: Ph-190(C) or equivalent.

Ph-196(C) Review of General Physics 5-0

A review of statics and dynamics. A survey of temperature, heat, kinetic theory, electricity and magnetism, wave motion and sound, and selected topics in light as time permits.

Text: Sears and Zemansky: University Physics.

Prerequisite: Ph-191(C) or equivalent.

Ph-197(C) Review of Physics I 3-0

Statics and dynamics of particles, solids and fluids. Temperature, heat, radiation, kinetic theory and gas laws. Basic differential and integral calculus is used.

Text: Sears and Zemansky: University Physics.

Prerequisites: A previous course in college physics, Ma-100(C) and Ma-101(C). (To be taken concurrently.)

Ph-198(C) Review of Physics II 3-0

A continuation of Ph-197(C). Wave motion, sound, electricity, magnetism and such selected topics in light as time permits.

Text: Sears and Zemansky: University Physics.

Prerequisite: Ph-197(C).

Ph-240(C) Optics and Spectra 3-3

Reflection and refraction of light, optical systems, dispersion, interference, diffraction, polarization. Basic atomic structure, photoelectric effect, radiation from atoms, molecules and solids.

Texts: Sears: Optics; Jenkins and White: Fundamentals of Optics.

Prerequisite: None.

Ph-241(C) Radiation 3-3

Fundamentals of geometric and physical optics. Wave phenomena and wave propagation. Origin of the quantum theory, photoelectric effect, radiation from atoms, molecules and solids.

Texts: Sears: Optics; Jenkins and White: Fundamentals of Optics.

Prerequisite: None.

Ph-311(B) Electrostatics and Magnetostatics 3-0

Coulomb's law, Gauss' law, dipoles, dielectric theory, polarization, harmonic solutions of Laplace's equation, electrical images, magnetic dipoles and shells, Ampere's law, magnetic field of current, magnetic theory. Both analytical and vector methods are used.

Texts: Slater and Frank: Electromagnetism; Whitmer: Electromagnetics.

Prerequisites: Ma-103(B); Es-112(C).

Ph-312(A) Applied Electromagnetics 3-0

A continuation of Ph-311 with particular emphasis on magnetic fields of significance to mine warfare. Propagation of induction and radiation fields of electromagnetic waves.

Texts: Slater and Frank: Electromagnetism; Whitmer: Electromagnetics.

Prerequisite: Ph-311(A).

Ph-341(C) Electricity and Magnetism 4-2

DC and AC circuits, elementary electrostatics, vacuum tubes, coupled circuits, filters, lines, vacuum tube circuits. The treatment emphasizes the physical aspects of these phenomena.

Texts: Winch: Electricity and Magnetism; lecture notes.

Prerequisite: Ma-182(C). (May be taken concurrently.)

Ph-361(A) Electromagnetism 3-0

Electromagnetic field theory; electrostatics, dielectrics, magnetic fields of currents; vector potential; magnetic materials; magnetomotive force; electromagnetic induction; Maxwell's equations; electromagnetic waves.

Text: Slater and Frank: Electromagnetism.

Prerequisites: Ma-104(A) and EE-272(B), or equivalent.

Ph-362(A) Electromagnetic Waves 3-0

A continuation of Ph-361(A). Reflection and refraction of electromagnetic waves; wave guides; cavity resonators; electromagnetic radiation.

Text: Slater and Frank: Electromagnetism.

Prerequisite: Ph-361(A).

Ph-421(B) Fundamental Acoustics 3-0

An analytical study of the dynamics of vibrating systems including free, forced, damped, and coupled simple harmonic motion; vibrations of strings, bars, and membranes. A development of the acoustic wave equation. Propagation of plane waves through pipes and between different media. Propagation of spherical waves, including radiation from pulsating sphere and circular piston. Acoustic filters and absorption of sound in fluids.

Text: Kinsler, Frey: Fundamentals of Acoustics.

Prerequisite: Ma-104(A) or Ma-193(B).

Ph-425(A) Underwater Acoustics 3-2

A continuation of Ph-421(B). An analytic treatment of the propagation of underwater acoustic waves as influenced by boundary conditions, refraction, reverberation, and attenuation. Physical characteristics of sonar transducers. Psychoacoustics, shock waves, sonar systems and developments, experimental measurements in underwater acoustics. Laboratory includes experiments in underwater acoustic measurements, sonar beam pattern, and operational characteristics of sonar equipment.

Texts: Kinsler, Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound; NDRC Technical Summary: Physics of Sound in the Sea.

Prerequisite: Ph-421(B) or 431(B).

Ph-426(B) Acoustics Laboratory 0-3

A laboratory course to accompany Ph-421(B). An experimental study of vibrating systems and acoustic radiations.

Text: None.

Prerequisite: Ph-421(B) or 431(B).

Ph-427(B) Fundamental Acoustics 3-0

A study of the dynamics of free, forced, and damped simple harmonic oscillators, strings, bars and membranes. Development of, and solutions to, the acoustic wave equation. Propagation of plane waves between different media. Beam patterns and directivity of acoustic radiation from a piston. Radiation reaction. Loudspeaker and cabinet design. Classical and molecular absorption of sound in free space and in tubes.

Text: Kinsler and Frey: Fundamentals of Acoustics.

Prerequisite: Ma-104(A).

Ph-428(A) Underwater Acoustics and Sonar Systems 3-3

A continuation of Ph-427 (B). Microphone and sonar transducer theory and design. Transmission of sound in sea water, including problems of refraction, attenuation, and reverberation. Physical principles, detection systems used in design and operation of current sonar equipment. New developments in sonar. Experiments in acoustical measurements, transducer measurements, sound beam and sonar equipment measurements, and noise analysis.

Texts: Kinsler and Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound.

Prerequisite: Ph-427(B).

Ph-431(B) Fundamental Acoustics 4-0

An analytical study of the dynamics of free, forced, and damped simple harmonic oscillators, strings, bars and membranes. Development of, and solutions to, the acoustic wave equation. Propagation of plane waves through pipes and between different media. Acoustic filters. Beam patterns and directivity of acoustic radiation from a piston. Radiation reaction. Loudspeaker and cabinet design. Classical and molecular absorption of sound in free space and in tubes.

Text: Kinsler and Frey: Fundamentals of Acoustics.

Prerequisite: Ma-104(A).

Ph-432(A) Underwater Acoustics and Sonar Systems 4-3

A continuation of Ph-431(B). Microphone and sonar transducer theory and design. Transmission of sound in sea water, including problems of refraction, attenuation, and reverberation. Physical principles, electronic circuits, detection systems used in design and operation of current sonar equipment. New developments in sonar. Experiments in acoustical measurements, transducer measurements, sound beam and sonar equipment measurements, and noise analysis.

Texts: Kinsler and Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound.

Prerequisite: Ph-431(B).

Ph-433(A) Propagation of Waves in Fluids 2-0

A theoretical treatment of the propagation of acoustic waves in fluids including both ray and wave propagation characteristics as well as second order effects.

Text: Instructor's notes.

Prerequisite: Ph-421(B) or Ph-431(B).

Ph-441(A) Shock Waves in Fluids 4-0

Simple Oscillator. Hydrodynamics. Longitudinal wave equation. Propagation of acoustic waves in fluids. Propagation of explosive shock waves in fluids. Shock waves propagated from atomic explosions.

Texts: Kinsler, Frey: Fundamentals of Acoustics; Cole: Underwater Explosions; AFSWP-Hirschfeller: The Effects of Atomic Weapons.

Prerequisites: Ma-183(B) and Ph-142(B).

Ph-442(A) Shock Waves in Fluids 3-0

Finite amplitude waves. Theory of propagation of explosive shock waves in fluids, Rankine-Hugoniot equation of shock front, scaling laws, experimental measurements of shock waves in water. Shock waves propagated from atomic explosions.

Text: Cole: Underwater Explosions.

Prerequisite: Ph-421(A).

Ph-450(B) Underwater Acoustics 3-2

An analytic treatment of the fundamentals of acoustics, with particular emphasis on sound radiation and transmission problems encountered in underwater acoustics.

Texts: Kinsler, Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound; NDRC Technical Summary; Physics of Sound in the Sea.

Prerequisite: Ma-102(C).

Ph-461(A) Transducer Theory and Design 3-3

A theoretical treatment of the fundamental phenomena inherent to the design of crystal, magnetostrictive, and ceramic sonar transducers. Characteristics and parameters of various sonar transducer systems are studied in the laboratory.

Texts: Hueter, Bolt: Sonics; NDRC Technical Summary: Crystal Transducers; instructor's notes.

Ph-471(A) Acoustics Research 0-3

Advanced laboratory work in acoustics.

Text: None.

Prerequisite: Ph-432(A) or equivalent.

Ph-530(B) Thermodynamics 3-0

Fundamental theory of thermodynamics and application to physical problems. First and second laws of thermodynamics, entropy, free energy, the phase rule, gaseous reactions, thermodynamics of dilute solutions, specific heats of gases, the Nernst heat theorem.

Text: Sears: Thermodynamics.

Prerequisites: Ph-113(B) or Ph-142(B), and Ma-103(B) or Ma-183(B).

Ph-540(B) Kinetic Theory and Statistical Mechanics 3-0

Properties of an ideal gas, Maxwell-Boltzman distribution, mean free path, collision cross-section, non-ideal gases, viscosity, heat conductivity, diffusion; introduction to classical and quantum statistics, including Fermi-Dirac and Bose-Einstein statistics.

Texts: Kennard: Kinetic Theory of Gases; Sears: Thermodynamics; lecture notes.

Prerequisites: Ph-113(B) or Ph-142(B), and Ma-103(B) or Ma-183(B).

Ph-541(B) Kinetic Theory and Statistical Mechanics 4-0

Maxwell-Boltzman distribution, collision cross-sections, introduction to classical and quantum statistics, with application to radiant energy.

Texts: Kennard: Kinetic Theory; Sears: Thermodynamics.

Prerequisites: Ma-183(B) and Ph-142(B).

Ph-542(B) Survey of Thermodynamics and Statistical Mechanics 4-0

The principal topics are: Equations of state, first and second laws of thermodynamics; introduction to classical and quantum statistics, including Fermi-Dirac and Bose-Einstein statistics; theory of fluctuations.

Text: Sears: Thermodynamics.

Prerequisites: Ph-113(B) or Ph-142(B), and Ma-103(B) or Ma-183(B).

Ph-610(B) Survey of Atomic and Nuclear Physics 3-0

An introductory course in atomic and nuclear physics. Elementary charged particles, photoelectricity, x-rays, radioactivity, atomic structure, nuclear reactions, nuclear fission.

Text: Semat: Atomic Physics.

Prerequisite: None.

Ph-620(B) Atomic Physics 3-0

The atom and kinetic theory, electrons as particles and waves, elementary quantum mechanics, atomic structure and spectra, molecular structure, introduction to fundamental nuclear particles and structure of nuclei, behavior of atoms in solids.

Text: Sproull: Modern Physics.

Prerequisites: Ph-240(C), Ph-113(B).

Ph-631(B) Atomic Physics 4-0

Dynamics of elementary charged particles, Rutherford's model of the atom and the scattering of alpha particles, special theory of relativity, Bohr model of the atom, Schroedinger wave equation, dipole radiation, optical spectra, Zeeman effect, magnetic moments, Pauli's principle, x-rays, photoelectric effect, natural radioactivity, the nucleus, artificial radioactivity.

Text: Richtmeyer and Kennard: Introduction to Modern Physics.

Prerequisite: Ph-361(A) or equivalent.

Ph-640(B) Atomic Physics 3-0

Elementary charged particles, photoelectricity, Bohr model of the hydrogen atom, optical and x-ray spectra, Zeeman effect, Compton effect, electron diffraction, special theory of relativity, Schroedinger's wave equation.

Texts: Finkelnburg: Atomic Physics; Semat: Atomic Physics.

Prerequisites: Ph-142(B) and Ph-240(C).

Ph-641(B) Atomic Physics Laboratory 0-3

An experimental study of the phenomena, observational methods, and instruments used in atomic physics.

Text: Laboratory notes.

Prerequisite: Ph-640(B). To be taken concurrently.)

Ph-642(B) Nuclear Physics 4-0

Nuclear structure, radioactivity, nuclear reactions and nuclear fission.

Text: Halliday: Introductory Nuclear Physics.

Prerequisites: Ph-640(B); Ph-720(A). (May be taken concurrently.)

Ph-643(B) Nuclear Physics Laboratory 0-3

An experimental study of the phenomena, observational methods, and instruments used in nuclear physics.

Text: Bleuler, Goldsmith: Experimental Nucleonics.

Prerequisite: Ph-642(B).

Ph-644(A) Advanced Nuclear Physics 4-0

A continuation of Ph-642(B). Nuclear forces; general theory of nuclear reactions. Application of theory to experiments. Elementary pile theory.

Texts: Blatt and Weisskopf: Theoretical Nuclear Physics; Glasstone and Edlund: The Elements of Nuclear Reactor Theory; lecture notes.

Prerequisite: Ph-642(B) or equivalent.

Ph-645(A) Advanced Nuclear Physics Laboratory 0-3

Nuclear bombardment experiments; research techniques in nuclear physics.

Texts: Bleuler, Goldsmith: Experimental Nucleonics; laboratory notes.

Prerequisite: Ph-644(A). (To be taken concurrently.)

Ph-650(A) Nuclear Instrumentation 4-0

Basic phenomena in gaseous discharges, particle accelerators, nuclear reactors, nuclear spectrometers, cloud chambers, scintillation detectors, Cerenkov detectors, and associated equipment.

Text: None.

Prerequisite: Ph-642(B).

Ph-651(A) Reactor Theory 3-0

Nuclear fission, the diffusion and slowing down of neutrons, homogeneous thermal reactors.

Text: Glasstone and Edlund: The Elements of Nuclear Reactor Theory.

Prerequisite: Ph-642(B).

Ph-710(B) Physics of the Solid State. 4-0

Crystal, classes, quantum theory of crystal lattices, electron theory of solids, conductivity, semiconductor phenomena, magnetic properties of solids, superconductivity, strength and mechanical properties of solids on the basis of dislocation theory.

Text: None.

Prerequisite: Ph-610(B).

Ph-720(A) Introductory Quantum Mechanics 3-0

Schroedinger's wave mechanics, with application to such problems as the free particle, particle in a potential well, harmonic oscillator and the hydrogen atom.

Text: Rojansky: Introductory Quantum Mechanics.

Prerequisite: Ph-640(B).

Ph-721(A) Introductory Quantum Mechanics 4-0

This course is designed to familiarize the student with the postulates and methods of Schroedinger's quantum mechanics, with application to such problems as the free particle, particle in a potential well, potential barriers, cold cathode emission, natural radioactivity, harmonic oscillator, free rotator, hydrogen atom and the one-dimensional potential lattice for the solid state.

Text: Rojansky: Introductory Quantum Mechanics.

Prerequisites: Ph-142(B) and Ph-640(B) or equivalent.

Ph-723(A) Physics of the Solid State 4-0

Crystal classes, interference phenomena. Quantum theory of crystal lattices, binding energies. Statistics of electrons in solids, band theory of solids, Brillouin zones, Hume-Rothery rule, electron negative mass and the "hole" concept. Conductivity, insulators and semiconductors, electron trapping, fluorescence, junction rectification, transistor action. Superconductivity, properties of liquid helium II. Magnetic properties of solids. Dislocations, strength and plastic flow.

Texts: Kittel: Introduction to Solid State Physics; Seitz: Modern Theory of Solids; Read: Dislocations in Crystals.

Prerequisite: Ph-631(B) or Ph-640(B).

Ph-730(A) Physics of the Solid State 3-3

Statistics of electrons in solids, band theory of solids, Brillouin zones, thermionic, photoelectric, and field emission, "hole" concept, conductivity, insulators and semi-conductors, photoconductivity, fluorescence, phosphorescence, junction rectification, transistor action. Magnetic and electric properties of solids, superconductivity.

Text: Kittel: Introduction to Solid State Physics.

Prerequisite: Ph-721(A).

Ph-731(A) Theoretical Physics 3-0

Topics in theoretical physics selected to meet the needs of the student.

Text: None.

Prerequisite: Consent of instructor.

Ph-750(A)Physics Seminar 1-0

Discussion of special topics of current interest in the field of physics and student thesis reports.

Text: None.

Prerequisite: Consent of instructor.

SECTION III

THE GENERAL LINE SCHOOL

Director

Williston Lamar DYE, Captain, U. S. Navy
B.S., USNA, 1929;
USNPS, Applied Communications, 1938.

Assistant Director

Albert Peyton COFFIN, Captain, U. S. Navy
B.S., USNA, 1934; Air War College, Maxwell Field, Ala.

Assistant Director (Waves)

Elizabeth Spencer HARRISON, Lieutenant Commander, U. S. Navy
A.B., Western Maryland College, 1937;
M.Ed., Western Maryland College, 1947.

Administrative Officer

Edgar Smith PALMER, Lieutenant Commander, U. S. Navy

Scheduling Officer

Wayne LeRoy JENSEN, Lieutenant, U. S. Navy
B.S., USNA, 1950.

NAVAL STAFF

ADMINISTRATION DEPARTMENT

Robert Edward PAIGE
Commander, U. S. Navy
Head of Department
B.S., USNA, 1939.

Harold Naylor HEISEL
Commander, U. S. Navy
Instructor in Administration and Leadership
B.A., Texas Western, 1936.

Verne Elmer GEISSINGER
Commander, U. S. Navy
Instructor in Principles of Management
A.B. University of Nebraska, 1940.

Alton Printess ADAMS
Commander, U. S. Navy
Instructor in Leadership.

James Stuart NEILL
Commander, U. S. Navy
Instructor in International Relations
B.S., Trinity College, 1940.

Thomas Carey FARRELL
Commander, SC, U. S. Navy
Instructor in Personal Affairs and Logistics
A. B. Tufts College, 1939.

Charles Leo NAGLE, Jr.
Lieutenant Commander, U. S. Navy
Instructor in Principles of Management
B.S., Louisiana State University, 1942.

Herbert Joseph A. HILLSON
Lieutenant Commander, U. S. Navy
Instructor in Psychological Warfare and Logistics

John Clarke ROBERTS, Jr.
Commander, U. S. Navy
Senior Instructor in Naval Justice and International Law
B.A., Univ. of Texas, 1939; LL.B., 1942.

Samuel Harris DINSMORE
Commander, U. S. Navy
Instructor in Naval Justice & Personnel Administration B.A., St. Martin College, 1946.

Daniel Donald McLEOD
Lieutenant Commander, U. S. Navy
Instructor in Naval Justice and Personnel Administration
LL.B., Univ. of Arkansas, 1936.

Burton MacLynn SMITH
Associate Professor of Speech and Lecturer in Leadership Psychology (1955)
A.B., University of Wisconsin, 1936; M. A., 1937.

William C. BOGGESS
Associate Professor of Speech (1956)
B.S., University of Southern California, 1951; M.S., 1954.
Captain (USAF-R)

OPERATIONS DEPARTMENT

Oliver Walton BAGBY
Commander, U. S. Navy
Head of Department
B.S., USNA, 1938; U. S. Naval War College, 1950.

Charles Koll HOLZER
Commander, U. S. Navy
Instructor in Tactics
B.S., California Maritime Academy, 1939.

Ronald Paul GIFT
Commander, U. S. Navy
Instructor in Operational Planning.

Joseph Brennan DRACHNIK
Commander, U. S. Navy
Instructor in Amphibious Operations
B.S., USNA, 1943.

Charles Eugene STASTNY
Commander, U. S. Navy
Instructor in ASW
B.S., USNA, 1943.

Curtis D. McGAHA
Commander, U. S. Navy
Instructor in CIC.

Dan Albert DANCY
Lieutenant Commander, U. S. Navy
Instructor in Amphibious Operations
B.S., California Maritime Academy, 1939.

Muir Carsten CRITTENDEN
Lieutenant Commander, U. S. Naval Reserve
Instructor in Operational Planning
B.S., Univ. of Southern California, 1934..

Thomas Chapman YOUNG
Lieutenant Commander, U. S. Navy
Instructor in CIC.

Robert Carl MAY
Lieutenant, U. S. Navy
Instructor in Tactics
B.S., Brown University, 1945.

Mitchell Joseph KARLOWICZ
Lieutenant, U. S. Navy
Instructor in ASW
B.S., USNA, 1946.

James Creighton WILSON
Lieutenant, U. S. Navy
Instructor in Tactics
B.S., USNA, 1949.

SEAMANSHIP AND NAVIGATION DEPARTMENT

Delbert Massey MINNER
Commander, U. S. Navy
Head of Department
B.A., University of Delaware, 1935; M.A., George Washington Univ. 1950; Armed Forces Staff College, 1947.

Alexander William BELIKOW
Commander, U. S. Navy
Instructor in Naval Aviation.

Harold Carl STIRLING
Commander, U. S. Navy
Instructor in Navigation.

Bernard Norman GOCKEL
Commander, U. S. Navy
Instructor in Naval Aviation
B.S., Univ. of Tennessee, 1940.

John Stephen MALAYTER
Lieutenant Commander, U. S. Navy
Instructor in Seamanship.

William Scott PEASE
Lieutenant Commander, U. S. Navy
Instructor in Communications.

George B. OLSON
Lieutenant Commander, U. S. Navy
Instructor in Navigation.

Luke Oscar CONERLY, Jr.
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., USNPS, 1954.

Louis Wilford NOCKOLD
Lieutenant, U. S. Navy
Instructor in Seamanship and Communications.

Albert Francis SHIMMEL
Lieutenant, U. S. Navy
Instructor in Communications
B.S., USNA, 1948.

ORDNANCE AND GUNNERY DEPARTMENT

Jack Jones HINMAN, III
Commander, U. S. Navy
Head of Department
B.S., USNA, 1940; M.S., Massachusetts Institute of Technology, 1946.

Lee George MILLS
Commander, U. S. Navy
Instructor in New Ordnance Developments

Robert Joseph NELSON
Commander, U. S. Navy
Instructor in Restricted Weapons

Frederick LEIST, Jr.
Lieutenant, U. S. Navy
Instructor in Guided Missiles

John Douglass CALLAWAY, Jr.
Lieutenant, U. S. Navy
Instructor in Mine Warfare and Harbor Defense
B.S., USNA, 1946.

Richard William ANDERSON
Lieutenant, U. S. Navy
Instructor in Guided Missiles
B.S., USNA, 1946.

Fremont Easton REICHWEIN
Lieutenant, U. S. Navy
Instructor in Basic Ordnance and Fire Control
B.S., California Institute of Technology, 1946.

ENGINEERING DEPARTMENT

Millard John SMITH
Captain, U. S. Navy
Head of Department
B.S., USNA, 1936.

Kenneth Frederick SHIFFER
Commander, U. S. Navy
Senior Instructor in Damage Control and Marine Engineering
B.S., M.S., USNPS, 1954.

Roy Earl HUETTEL
Commander, U. S. Navy
Instructor in Marine Engineering.

Francis Norbert BIEWER
Lieutenant Commander, U. S. Navy
Instructor in Engineering Trends and Developments
B.S., USNA, 1943; B.S., USNPS, 1950; M.S., USNPS, 1951.

Laurence Griffith BROOKS
Lieutenant Commander, U. S. Navy
Instructor in Marine Engineering and Atomic Biological and Chemical Warfare Defense.

William Edwin WALKUP
Lieutenant Commander, U. S. Navy
Instructor in Atomic, Biological and Chemical Warfare Defense, and Damage Control.

Wharton Hillman BROOKS, Jr.
Lieutenant, U. S. Navy
Instructor in Engineering Materials and Damage Control
B.S., USNA, 1947; N.E., M.I.T., 1953.

ACADEMIC DEPARTMENT

Frank Emilio LA CAUZA
Professor of Electrical Engineering, Head of Department (1929)*.
B.S., Harvard Univ., 1923; M.S., 1924; A.M., 1929.
Captain USNR

Edward Markham GARDNER
Professor of Electrical Engineering (1948).
B.S., Univ. of London, 1923; M.S., California Institute of Technology, 1938.

John Dewitt RIGGIN
Professor of Electrical Engineering (1946).
B.S., Univ. of Mississippi, 1934; M.S., 1936.
Commander USNR.

Raymond Kenneth HOUSTON
Professor of Electrical Engineering (1946).
B.S., Worcester Polytechnic Institute, 1938; M. S., 1939.

David Boysen HOISINGTON
Associate Professor of Electrical Engineering (1947).
B.S., Massachusetts Institute of Technology, 1940; M.S., University of Pennsylvania, 1941.

Raymond Patrick MURRAY
Associate Professor of Electrical Engineering (1947)
B.S., Kansas State College, 1937; M.S., Brown Univ., 1953.
Lieutenant Commander, USNR.

John Miller BOULDRY
Associate Professor of Electrical Engineering (1946)
B.S., Northeastern Univ., 1941. LCDR USNR.
M.S., Brown Univ., 1956.
Lieutenant Commander, USNR.

Darrel James MONSON
Assistant Professor of Electrical Engineering (1951).
B.S., Univ. of Utah, 1943; M.S., Univ. of California, 1951.

William Everett NORRIS
Assistant Professor of Electrical Engineering (1951).
B.S., Univ. of California, 1941; M.S., 1950.
Captain USNR.

Herbert LeRoy MYERS
Assistant Professor of Electrical Engineering (1951).
B.S., Univ. of Southern California, 1951.

* The year of joining the General Line School faculty is indicated in parentheses.

THE GENERAL LINE SCHOOL

OBJECTIVE

To broaden the mental outlook and to increase the professional knowledge of line officers in such a manner as to enable them to meet the duties, responsibilities and complexities of higher rank, thereby improving the efficiency and combat readiness of the Navy.

CURRENT AND FUTURE PROGRAMS

The present program, referred to as the Nine and One-Half Month Program, is similar to that which existed prior to World War II, complies with the general objectives of that previous curriculum, and is designed for all career line officers who have completed five to seven years of commissioned service.

The Nine and One-Half Month Program is designed to broaden the individual officer's knowledge, mental outlook, individual growth, initiative, and problem-solving ability.

In February, 1956, women line officers of the Regular Navy with five to seven years of commissioned service were enrolled for a twenty-week curriculum to be conducted concurrently with the Nine and One-Half Month Program. It is planned to have three inputs per year of approximately twenty women officers each. The Program exempts women officers from courses designed primarily for seagoing officers but has the same general objectives of broadening the mental outlook and increasing the professional knowledge of women line officers.

ADMINISTRATION

Responsibility for administration of the General Line School under the Superintendent, U. S. Naval Postgraduate School, rests in the Director. Under the Director is the staff.

The staff consist of six department heads five naval officers and one civilian and such additional officers and civilians as may be assigned to those departments as instructors.

The officer students of the General Line School are divided into sections for the purpose of administration and classroom assignments. The senior officer of each section is designated section leader with responsibility for exercising administrative control of the officers in his section. Each student section has an officer instructor assigned to it as section advisor. The section advisor provides a connecting link between the school administration and the students.

FACILITIES AND EQUIPMENT

The General Line School occupies the East Wing of the Administration Building. In this wing, in addition to classrooms, are contained the offices of the Director, heads of departments, and instructors. Other buildings contain laboratories and facilities for practical exercises.

One of these buildings contains training aid models and actual engineering plant equipment such as would be installed in a modern destroyer. The boiler, turbines, reduction gear and pumps which comprise the actual engineering equipment have been sectionalized and are demonstrated as cut-away models for better display and instructional purposes.

Classes in Combat Information Center operations and in anti-submarine warfare are conducted in a specially designed building which houses two classrooms, two CIC mock-ups, two Sonar ASW attack-direction system mock-ups and associated problem generators, an electronics workshop, and an office for the instructors. The mock-ups simulate the installations found on the latest-type radar picket destroyers and are constructed to permit the two "ships" to simulate the procedures and maneuvers used in making coordinated attacks against a submarine. Officer students man and control the bridge, sonar, and CIC stations, which are used during simulated task force problems and anti-submarine attacks. These problems and attacks are made to demonstrate to the students the principles which they study during the classroom sessions.

In another building, Powers Hall, are located facilities for practical exercises in navigation, during which the students utilize the equipment, charts, and publications normally available to a navigator on board a ship.

The Academic Department laboratories of the General Line School are designed to illustrate the principles of electrical engineering, electronics and a certain amount of physics and nucleonics from a practical point of view.

The following ordnance and associated equipment is available for laboratory purposes in the Gun Mount Building: 5″/38 caliber dual-purpose gun mount, 3″/50 caliber rapid fire gun mount, representative AA fire control equipment, mines, rocket launcher, torpedoes, and guided missiles.

CURRICULUM AND INSTRUCTION

The curriculum of the Nine and One-Half Month Program is designed to accomplish its mission and tasks by being divided into three well-integrated areas of subject content, each area supplementing the other two. These areas are:

1. **Exemptive Subjects**, the objective being primarily that of equalizing the basic education of all officer students. Through controlled scheduling and individual counseling the curriculum will reinforce

prior education and experience and will fill the gaps of professional knowledge which may exist through differences in the education and experience of the officer student.

2. **Required** Subjects, the objective being to integrate the education and experience of the officer. Also, this area will afford an opportunity to perfect the officer's understanding of the professional responsibilities of command rank and will provide an opportunity for the officer to elevate his own professional growth.

3. **Elective** Subjects, the objective being to allow officer students to pursue professional fields which will provide an opportunity for them to develop independent judgement in professional areas of high personal and naval interest and will result in a professional growth beneficial to the Navy and the individual officer.

Electives will be offered in accordance with the needs and desires of the officer students with proper consideration for those limitations imposed by the availability of staff personnel, facilities, and time.

CURRICULUM (Nine and One-Half Month Program)

Academic Department	Hours
Exemptive Courses	
Mathematics Refresher	36
Physics Refresher	27
D.C. Circuits and D.C. Machinery	36
A.C. Circuits and A.C. Machinery	45
Electronics	54
Required Courses	
Nucleonics	18
Elective Courses	
Mathematics—Calculus	54
Physics	54
Nucleonics for the Navy	54

Administration Department	
Exemptive Courses	
Naval Justice I	27
Naval Justice II	18
Required Courses	
Logistics and Supply	18
Leadership	36
Principles of Management	36
Internationl Relations and National Security	27
Elective Courses	
Psychological Warfare	27
International Law I	27
International Law II	27
Recent Naval History	36
Personnel Administration	27
Effective Speech	36
Group Procedures	27
Personal Affairs	18

Ordnance and Gunnery Department	Hours
Exemptive Courses	
Basic Ordnance and Fire Control	27
Required Courses	
New Ordnance Concepts and Equipment	27
Guided Missiles	27
Restricted Weapons	27
Mine Warfare	36
Elective Courses	
Harbor Defense	18

Operations Department	
Exemptive Courses	
Tactics I	36
Required Courses	
Tactics II	27
Operational Planning	36
Amphibious Operations	36
Combat Information Center Operations	36
Anti-Submarine Warfare	36
Submarine Indoctrination	

Seamanship and Navigation Department	
Exemptive Courses	
Seamanship'	27
Navigation I	36
Communications I	27
Communications II	27
Naval Aviation	27
Aerology	27
Elective Courses	
Intelligence	18
Navigation	36

Engineering Department	
Exemptive Courses	
Marine Engineering	36
Damage Control	27
Atomic, Biological, and Chemical Warfare Defense	27
Required Courses	
Engineering Trends and Developments	18
Elective Courses	
Engineering Materials	27

CURRICULUM (Twenty-Week Program for Women Line Officers)*

Academic Department	
Elective Courses	
Nucleonics	18

Administrative Department	
Exemptive Courses	
Naval Justice I and II	45
Required Courses	
Leadership	36
Logistics	18
Principles of Management	36

	Hours
International Relations and National Security	27
Personnel Administration	27
Elective Courses	
International Law I and II	54
Psychological Warfare	27
Effective Speech	36
Group Procedures	27
Personal Affairs	18
Engineering Department	
Elective Courses	
ABC Warfare Defense	27
Operations Department	
Elective Course	
Operational Planning	36
Seamanship and Navigation Department	
Exemptive Courses	
Communications I(W) and II(W)	36
Intelligence	18
Aerology	27

* Including such other electives as time and qualifications allow.

ADMINISTRATION DEPARTMENT

Naval Justice I and II — **Exemptive (45)**

OBJECTIVE

A course to provide an understanding of UCMJ and its application to military duties in order that the administration of justice may function effectively.

COURSE DESCRIPTION

The course covers: jurisdiction; charges and specifications; punitive articles; evidence; non-judicial punishment; investigations; summary, special, and general courts-martial; punishments; fact-finding bodies.

Logistics and Supply — **Required (18)**

OBJECTIVE

A course to give the officer-student an appreciation of the logistic problems of the nation as a whole, the Armed Forces, and naval operating forces.

COURSE DESCRIPTION

The major topics include: meaning and concept of Logistic Support; manpower; petroleum; logistic organizations and commands; transportation and supply at the fleet level; shipboard logistic, supply and fiscal problems.

Leadership — **Required (36)**

OBJECTIVE

A course to examine the nature of Leadership and to study its application through the medium of case studies.

COURSE DESCRIPTION

Topics included in this course are: elementary psychology; military philosophy; the techniques of leadership; case studies in Leadership.

Principles of Management — **Required (36)**

OBJECTIVE

A course to present the cycle of administration, the fundamentals of personnel handling, and other elements encountered in the solution of various Naval organizational problems.

COURSE DESCRIPTION

Planning is discussed with emphasis on types of plans, limitations, and the analytical approach to method. Attention is directed to the principles of organization including: grouping functions, delegation, line, staff and functional structure, span of conrtol. The principles of direction and control are analyzed. Case discussions are employed to focus attention and elicit student participation.

International Relations and National Security — **Required (27)**

OBJECTIVE

A course to present the role of the United States in world affairs, including the collective security organizations to which the United States belongs; and to emphasize the inter-relationship of various governmental agencies in the execution of national policy and the guarantee of national security.

COURSE DESCRIPTION

The course includes: the National Security Act of 1947; the Departments of State and Defense; treaty organizations; military and economic aid programs; the relationship of all the various cabinet level departments in the over-all scheme of National Security.

Psychological Warfare — **Elective (27)**

OBJECTIVE

A course on psychologically waged warfare in which propaganda is the weapon utilized to accomplish, or to facilitate the acomplishment of, national objectives.

COURSE DESCRIPTION

The course includes: the evolution of Psychological Warfare; national and serviec organizations for Psychological Warfare; social groups and propa-

ganda analysis; basic objectives and effects of propaganda; appeal and timing of delivery of propaganda; and research projects into the use and value of Psychological Warfare as conducted by nations.

International Law I **Elective (27)**

OBJECTIVE

A course to present the fundamentals of international law with special reference to the practical problems of the naval officer.

COURSE DESCRIPTION

The course covers: historical background of international law, its scope and sources; "international persons" with special reference to the United Nations; jurisdiction over trritory marginal seas, air spaces and territorial waters, gulfs, straits, and special bodies of waters; the high seas; application and interpretation of fundamentals of inter-national law; problem discussions.

International Law II **Elective (27)**

OBJECTIVE

A course to present additional fundamentals of international law with particular references to the rules of land, aerial and maritime warfore; to present advanced problems in international law and the methods for their solution with special reference to the practical problems of the naval officer.

COURSE DESCRIPTION

The course covers: international treaties; rules of land, aerial and maritime warfare, rules relative to prisoners-of-war; relations of belligerents and neutrals; military government; war crimes; the advanced application and interpretation of the rules of international law; the solution of theoretical problems; problem discussions.

Recent Naval History **Elective (36)**

OBJECTIVE

A course to present through historical study an over-all view of modern naval operations.

COURSE DESCRIPTION

Included in the course will be: the Battle of the Atlantic; the Guadalcanal Operation; the Saipan Operation; the Normandy invasion; the Philippine invasion; the Okinawan invasion; the Inchon invasion; a survey of Korean naval operations.

Personnel Administration **Elective (27)**

OBJECTIVE

A course laid out to present the principles and procedures for proper personnel administration at the shipboard level. Emphasis is placed in economical and efficient utilization of available personnel.

COURSE DESCRIPTION

The major parts of the course are organization, supervision, and assignment of personnel; efficient utilization; training; education; welfare programs; morale factors; personnel accounting.

Effective Speech **Elective (36)**

OBJECTIVE

A course to increase the officer-student's ability to organize and express information and thought before military and civil groups, and to obtain desired reactions from an audience.

COURSE DESCRIPTION

The course includes the study of effective techniques for organizing and delivering speeches, a speech clinic for analyzing the speech needs of each student, and an opportunity to deliver speeches of varying length and purpose (including presentations using graphic aid) with the group as an audience. Time will be devoted to improving the student's ability to prepare and make effective presentations and briefings.

Personal Affairs **Elective (18)**

OBJECTIVE

A course to acquaint the officer-student with the fundamentals of sound career and estate planning.

COURSE DESCRIPTION

Topics include: career planning; retirement and separation; selection and promotion; commercial and government life insurance; government benefits; investments; estate planning; liability; health and casualty insurance.

Group Procedures **Elective (27)**

OBJECTIVE

The objective of this course is to present selected theory from the field of group procedures and to provide an opportunity to apply the theory in practical situations while learning.

COURSE DESCRIPTION

This course is designed to provide a knowledge of the basic skills which will allow officers to function more effectively in working with others. The course presents a brief background of the development of group work and presents in detail the "forces" that determine the behavior of individuals in groups. Practical application of the theory is provided by actually working in groups on assigned problems.

OPERATIONS DEPARTMENT

Tactics I — **Exemptive (36)**

OBJECTIVE

To familiarize the student with fundamental tactical doctrines, arrangements, and techniques.

COURSE DESCRIPTION

The main topics included are: task organization and command, formations, dispositions, applications of maneuvering board principles, screening, scouting, search and rescue, and general cruising instructions.

Tactics II — **Required (27)**

OBJECTIVE

To familiarize the student with advanced tactical concepts and their application to various types of operations.

COURSE DESCRIPTION

The broad topics covered are: Striking force operations, convoy and escort instruction, replenishment, strategic use of submarines, measures to avoid mutual intereference, tactical employment of electronic countermeasures and analytical study of selected operations of WW II, Korean and current operations.

Operational Planning — **Required (36)**

OBJECTIVE

To acquaint the student with the problems and principles inherent in naval planning in order that he may understand planning procedures and carry out military directives in a discerning and farsighted manner.

COURSE DESCRIPTION

Topics covered include: Principles of planning; the planning process; analysis of the military directive; format and content of annexes, appendices and tabs; the determination of requirements (including logistics) incident to the mission.

Amphibious Operations — **Required (36)**

OBJECTIVE

To give the student an over-all view of amphibious warfare with emphasis on planning requirements.

COURSE DESCRIPTION

Major items of study are: organization, command, equipment, naval gunfire support, ship-to-shore movement, protective measures, communications, and logistics of an amphibious operation.

Anti-Submarine Warfare — **Required (36)**

OBJECTIVE

To present the problems of detection, attack and destruction of hostile undersea craft, with particular emphasis on the capabilities and limitations of the various current ASW weapons and the hunter-killer group employing them.

COURSE DESCRIPTION

The first phase of the course is devoted to a study of the design, operational characteristics, capabilities and limitations of the various submarine types. The second phase deals with anti-submarine search and rescue, detection (air, surface, and sub-surface), anti-submarine weapons systems, tracking of submarines and attack techniques employed against submarines. The final phase covers coordinated anti-submarine actions designed to find and destroy hostile undersea craft.

Submarine Indoctrination — **Required (No Credit)**

OBJECTIVE

To give the officer-student the opportunity to make a short trip in a modern fleet submarine from which he can gain a first-hand appreciation of the capabilities and limitations of an undersea craft.

COURSE DESCRIPTION

After a preliminary briefing, officer-students are divided into small groups which rotate through a submarine during a short period of submerged operations in areas close to Monterey. They are given an opportunity to observe closely the functioning of all control stations.

Combat Information Center — **Required (36)**

OBJECTIVE

A course to present the capabilities, limitations and techniques of the Combat Information Center with emphasis on procedures.

COURSE DESCRIPTION

Topics include: conduct of air, surface and subsurface searches; problems relative to the control of airborne aircraft; conduct of Anti-Submarine Warfare operations; tactical control of naval units; conduct of electronic countermeasures; recognition training; material care and operations.

SEAMANSHIP AND NAVIGATION DEPARTMENT

Seamanship — **Exemptive (27)**

OBJECTIVE

To review the fundamental phases of seamanship, with emphasis on the duties and responsibilties of a naval line officer as a conning officer and as an officer of the deck underway and in port.

COURSE DESCRIPTION

Topics include: the duties of an officer of the deck both underway and in port; maintenance of the deck log; conning a ship alongside and away from a pier, in narrow channels, and in "man overboard" procedures; use of anchors and methods of anchoring; mooring (ordinary, flying, to a buoy, Mediterranean); replenishment at sea; cargo-handling and stowage; Rules of the Nautical Road, both international and inland.

Navigation I **Exemptive (36)**

OBJECTIVE

To provide the officer-student with a working knowledge of the duties of a ship's navigator, including marine piloting, radar and loran navigation.

COURSE DESCRIPTION

Topics included in the course are: charts, buoys, navigation lights, tides and currents, magnetic and gyro compasses, the navigator's records, the deck log, voyage planning, electronic navigation devices; practical works are given which require the use of hydrographic publications and the actual performance of chart work.

Navigation II **Elective (36)**

OBJECTIVE

To provide the officer-student with a basic working knowledge of celestial navigation.

The course covers an introduction to astronomy, the practical use of navigational publications used in connection with celestial navigation. The various phases of celestial navigation used by the navigator at sea; practical works include the entire navigator's day's work at sea with the exception of the actual taking of observations.

Communications I **Exemptive (27)**

OBJECTIVE

To acquaint the student with the doctrine, policies, and principles governing fleet operational communications, with emphasis on capabilities, limitations, procedures, and responsibilities.

COURSE DESCRIPTION

Topics included are: The communication organization; functions of the Naval Communications System; instructions and procedures for radio and visual communications; command responsibilities; control of electromagnetic radiations (CONELRAD); the Allied Naval Signal Book.

Communications II **Required (27)**

OBJECTIVE

To familiarize the student with those phases of a communication officer's duties beyond the basic princples and procedures covered in Communications I.

COURSE DESCRIPTION

The major topics presented are: naval postal affairs; security; the registered publications system; communication planning (as typified by attack carrier task force and amphibious task force communication and frequency plans).

Communications I **Exemptive (18)**

OBJECTIVE

To acquaint the woman officer student with the duties, responsibilities, and procedures of the Naval Communications System, which she would encounter in a shore communications billet.

COURSE DESCRIPTION

Topics include: the communications organization; functions of the Naval Communication System; instructions and procedures regarding reporting systems, communications station organization and files, mesage drafting and preparation for transmission, postal affairs, security of classified matter.

Communications II-W **Exemptive (18)**

OBJECTIVE

To acquaint the woman officer student with further duties, responsibilities, and procedures of the Naval Communications System encountered in a shore communications billet.

COURSE DESCRIPTION

Topics include: duties and responsibilities of a Registered Publications custodian communications planner, and cryptographer; familiarization with basic publications required in such billets.

Intelligence **Elective (18)**

OBJECTIVE

To present the sources, uses and importance of intelligence.

COURSE DESCRIPTION

The topics covered include: a general background of intelligence, communism and geopolitics; the naval intelligence organization; the intelligence cycle; counter-intelligence; intelligence in support of an operational command; the function of the line officer in the collection of intelligence.

Aerology **Exemptive (27)**

OBJECTIVE

The objective of this course is to present the principles of aerology and weather phenomena and their effects on naval operations.

COURSE DESCRIPTION

Topics to be discussed include: the structure of the atmosphere; the weather elements; the station model; pressure and winds; theory of air masses and fronts; tropical storms; sources of weather information; sea and surf conditions; climatology and the principles of weather map analysis and weather forecasting.

Naval Aviation — Exemptive (27)

OBJECTIVE

To give the Naval Officer a comprehensive understanding of Naval Aviation.

COURSE DESCRIPTION

The course includes discussions applicable to all phases of Naval Aviation. Emphasis is placed on the inter-relationships between the SHORE ESTABLISHMENT and the OPERATING FORCES in matters affecting Naval Aviation. Lectures peculiar to the OPERATING FORCES are based on the:

Mission
Tasks
Aircraft/Ships
and
Tactical Employment

peculiar to the overall Naval Aviation weapons system.

ORDNANCE AND GUNNERY DEPARTMENT

Basic Ordnance and Fire Control — **Exemptive (27)**

OBJECTIVE

To provide the officer-student who has had limited schooling and experience in ordnance and fire control with an understanding of the basic fundamentals and principles of naval ordnance and fire control.

COURSE DESCRIPTION

The course includes presentation of the basic principles and nomenclature associated with ordnance and fire control, followed by the application of these principles in currently installed equipment. Special considerations are presented relative to shipboard and aircraft gunnery, torpedoes, ASW weapons, rockets, bombs and bombing, shipboard fire control, and naval gunfire support.

New Ordnance Concepts and Equipment — **Required (27)**

OBJECTIVE

To inform officer-students of new developments and trends in ordnance and fire control equipments, their capabilities, limitations and concepts of their application; to stimulate the thinking and broaden the mental outlook of officers in these fields.

COURSE DESCRIPTION

The course includes new and planned developments in the fields of anti-aircraft gunnery systems, explosives, lethal devices, fuzes, underwater ordnance and fire control equipment, and aircraft armament systems. Special considerations are presented relative to military requirements, capabilities, limitations, and cost effectiveness.

Guided Missiles — **Required (27)**

OBJECTIVE

To develop in the officer-student an understanding of the capabilities and limitations of guided missiles.

COURSE DESCRIPTION

The course includes a survey of propulsion systems and guidance systems employed in guided missiles, discussion of specific missiles being developed for naval use, and the special considerations arising in the employment of these weapons in naval warfare.

Restricted Weapons — **Required (27)**

OBJECTIVE

To acquaint officer-students with family of special weapons available and those proposed together with their capabilities and limitations.

COURSE DESCRIPTION

The course includes a presentation of the naval problems incident to the procurement, stowage, test, assembly, and offensive use of each of the special weapons. In addition the offensive phase of bacteriological and chemical warfare is presented in general terms for indoctrinational purposes.

Mine Warfare — **Required (36)**

OBJECTIVE

To apprise officer-students of the importance of mine warfare and to provide the knowledge necessary for its conduct, both offensively and defensively.

COURSE DESCRIPTION

The course includes minefield characteristics and planning principles, capabilities and limitations of mine countermeasures equipment and craft; mine countermeasures planning; and new developments in mine warfare.

Harbor Defense — **Elective (18)**

OBJECTIVE

To acquaint officer-students with the principles and methods of defending a harbor.

COURSE DESCRIPTION

The course includes the development, mission, organization, equipments, tactical subdivision, and planning of harbor defense; Harbor Defense Command Center and port control operations; and harbor defense systems evaluation.

ENGINEERING DEPARTMENT

Marine Engineering **Exemptive (36)**

OBJECTIVE

The objective of this course is to review naval shipboard engineering, stressing operation, care and maintenance of a steam propulsion machinery installation and associated auxiliaries.

COURSE DESCRIPTION

The course includes the following topics: boilers and boiler auxiliaries, turbines and turbine auxiliaries, piping systems, auxiliaries outside the main machinery spaces, organization and administration of a shipboard Engineering Department, and shipboard electrical installations.

Damage Control **Exemptive (27)**

OBJECTIVE

The objective of this course is to review the basic principles of Damage and Casualty Control.

COURSE DESCRIPTION

Major topics include: the fundamentals of stability, shipboard damage control organization, shipboard damage control systems, and repair of damage.

Atomic, Biological, and Chemical Warfare Defense **Exemptive (27)**

OBJECTIVE

The objective of this course is to give the officer students an appreciation of the effects of atomic, biological and chemical weapons upon personnel and material; to present the methods and means of protecting against and minimizing the above effects; and to present the procedures for re-establishment of normal operations after having suffered an attack which employed the above weapons.

COURSE DESCRIPTION

The course includes the following major topics: an introduction to the characteristics and effects of the atomic, biological, and chemical weapons insofar as they affect defense; detection and evaluation of the effects of these weapons; suppressive and corrective action required to counter the effects of these weapons in order to permit the earliest resumption of normal operations.

Engineering Trends and Developments **Required (18)**

OBJECTIVE

The objective of this course is to acquaint the student with new developments and trends in naval ship propulsion.

COURSE DESCRIPTION

The fields of steam, diesel and nuclear propulsion and gas turbines are covered. Topics include forced circulation boilers, high temperature and high pressure steam, high speed lightweight diesel engines, nuclear propulsion plants of USS NAUTILUS and USS SEAWOLF, gas turbine installations for ship and boat propulsion and problems pertaining thereto; and the limitations of naval ship propulsion plants.

Engineering Materials **Elective (27)**

OBJECTIVE

To give an appreciation of the physical characteristics and naval applications of metals, plastics, and petroleum products with specific attention to new developments.

COURSE DESCRIPTION

The course includes the following: in metals—principles of physical metallurgy including equilibrium diagrams and changes in the solid state, alloys of iron and carbon, non-ferrous alloys, new metals and alloys, high temperature and corrosion problems; in plastics—the new types of synthetic fibers and elastic materials; in the petroleum industry—the advances in lubricants, diesel fuels and high octaine gasolines.

ACADEMIC DEPARTMENT

Mathematics Refresher **Exemptive (36)**

OBJECTIVE

To present with adequate brevity a course in Algebra and Trigonometry.

COURSE DESCRIPTION

The course includes the following topics: exponents, logarithms, factoring, equations, complex numbers, vectors, proportions, angles, trigonometric functions and table graphs, radian measures, trigonometric equations, and oblique triangles.

Physics Refresher **Exemptive (27)**

OBJECTIVE

To present a course covering the Mechanics and Sound divisions of Physics with emphasis on Mechanics.

COURSE DESCRIPTION

Mechanics topics include: basic units, velocity and acceleration, laws of motion, force, power, energy, and circular motion. Sound topics include: wave motion, sound production and transmission, and naval applications.

Direct-Current Machinery **Exemptive (18)**

OBJECTIVE

To cover the fundamental and important applications of dc machinery, especially the naval aspects.

COURSE DESCRIPTIONS

Topics include the following: fundamental characteristics of shunt and compound generators; shunt, serise, and compound motors. Demontrations are utilized.

Alternating-Current Machinery **Exemptive (27)**

OBJECTIVE

To cover the fundamental and important applications of ac machinery, especially the naval aspects.

COURSE DESCRIPTION

Topics include the following: fundamental characteristics of alternators; synchronous and induction motors. Laboratory exercises and demonstrations are utilized.

Electronics **Exemptive (54)**

OBJECTIVE

To cover the fundamentals of electronics and important naval applications.

COURSE DESCRIPTION

The following topics are included: vacuum tubes, gas tubes, rectifiers, various types of transducers, oscillators, modulation, oscilloscopes, transistors, transmitters, and receivers, radar principles, and control systems. Appropriate laboratory exercises are included.

Electronic Systems **Elective (54)**

OBJECTIVE

To summarize electronics fundamentals and to present electronic systems with emphasis on naval applications.

COURSE DESCRIPTION

The course includes the following topics: dc and ac circuits, vacuum tubes, amplifiers, power supplies, transmitters, receivers, radar, sonar, loran, guided missiles and countermeasures.

Nucleonics Fundamentals **Exemptive (18)**

OBJECTIVE

The objective of this course is a presentation of the basic theory of the nuclear field.

COURSE DESCRIPTION

Emphasis is centered on the following topics: atomic structure, nuclear structure, radioactivity, equivalence of mass and energy, nuclear transformations, fission, fusion, production of fissionable materials, and instrumentation.

Calculus **Elective (63)**

OBJECTIVE

To present a college level course in differential and integral calculus covering both principles and applications with a preliminary review of basic mathematics.

COURSE DESCRIPTION

The course includes the following topics: algebraic and trigonometric fundamentals; variables, functions, and limits; differentiation of algebraic functions; differentiation of inverse and implicit functions with applications; successive differentiation and 2nd derivative applications; parametric equations; theorem of mean value; integration, definite integrals and applications; formal integration; centroids, fluid pressure and other applications.

Physics **Elective (54)**

OBJECTIVE

To present a college level course in general physics including all major subdivisions with the exception of electricity and nucleonics.

COURSE DESCRIPTION

These courses include the following topics: in mechanics—basic units; velocity and acceleration, laws of motion, force, power, and energy, circular motion; in sound—wave motion, sound production and transmission, naval applications; in light—reflection and refraction, dispersion, lens systems, optical instruments; in heat—thermal expansion, gas laws, heat transfer, laws of thermodynamics.

Nucleonics for the Navy **Elective (54)**

OBJECTIVE

The objective of this course is a presentation of the fundamentals of nucleonics followed by production of fissionable materials and instrumentation. (It is one of the most important naval correspondence courses.)

COURSE DESCRIPTION

The following topics are emphasized: structure of matter; structure of the atom; nuclear structure; nuclear transformations covering radioactivity and equivalence of mass and energy; transformation equations; high energy particles; fission and fusion; slow neutron reactions; military uses and tests of atomic bombs; peacetime applications; ionization instruments; instrument accuracy and applications; navy radiation instruments; photographic dosimetry.

SECTION IV

THE MANAGEMENT SCHOOL

DIRECTOR

John Adrian HACK, Captain, U. S. Navy
B.S., USNA, 1935;
B.A., Rensselaer Polytechnic Institute, 1950;
U. S. Naval War College, 1957.

ASSISTANT DIRECTOR

Alfred Paul BOILEAU, Commander, SC, U. S. Navy

ADMINISTRATIVE OFFICER

Kathryn DOUGHERTY, Commander, U. S. Navy

NAVAL STAFF

NAVAL STAFF

Alfred Paul BOILEAU
Commander, SC, U. S. Navy
B.S., Pennsylvania State University, 1941;
M.A., George Washington University, 1954
Instructor

Kathryn DOUGHERTY
Commander, U. S. Navy
B.A., Iowa State Teachers College, 1932;
M.A., Stanford University, 1952
Instructor

Joseph Alois KRIZ
Commander, SC, U. S. Navy
B.S., USNA, 1942; M.B.A., Columbia University, 1952
Instructor

Hunter Williamson STEWART
Commander, SC, U. S. Navy
B.S., Georgia Institute of Technology, 1941;
Staff, Navy Supply Corps School, 1950
Instructor

CIVILIAN FACULTY

William Howard CHURCH
Academic Chairman (1956)*
B.A., Whittier College, 1933; M.S.P.A., University of Southern California, 1941.

Vacancies in staff and faculty are not indicated.

* The year of joining the Postgraduate School faculty.

FUNCTION

The function of the Management School is to provide specialized education at the Postgraduate level for selected naval officers in order that they may serve effectively in the performance of their assigned duties. The broadening of the mental outlook and resultant increase in professional knowledge will enable the officers to better meet the duties, responsibilities, and complexities of higher rank, thereby improving the efficiency of the Navy.

This basic mission is accomplished in a five-month curriculum in which the principal task is instruction in a procedure of analysis which will lead to sound management decision and improved administrative achievement. This is done by providing a common basis of knowledge with emphasis upon the guiding principles and procedures characterizing successfully managed organizations. In order to foster individual growth, problem-solving ability, and initiative, sound management techniques and criteria are applied in actual case studies. The knowledge and experience of the officer student is fully utilized in accomplishing this task.

ORGANIZATION

The Management School is organized under its director, who is assisted by his staff. Under the Superintendent, U. S. Naval Postgraduate School, the Director is responsible for all phases of administration of the Management School.

The staff consists of an administrative unit and three departments. The department are as follows:

1. Financial Management Department, usually headed by a Commander, U. S. N., as department chairman.

2. Materiel Management Department, usually headed by a Commander, U. S. N.

3. Applied Management Department, usually headed by a civilian professor, designated the Senior Faculty Assistant.

Additional staff and faculty may be assigned to each of these departments as instructors.

Resident courses of study described in the curriculum are provided basically by these departments. Opportunities for certain elective courses within the Engineering School and the General Line School are provided in addition. Also, certain non-resident programs conducted entirely at civilian universities are administered by the Management School.

The officer students of the Management School are divided into sections for the purpose of administration and classroom assignments. The senior officer of each section is designated as section leader with responsibility for exercising administrative control over the officers in his section. Each section also has an officer instructor assigned to it as the section advisor. The section advisor provides the liason between school administration and the students.

FACILITIES

The offices and classrooms of the Management School are located in Root Hall. At special times, facilities of the Postgraduate School in other locations are utilized.

CURRICULUM

The Navy Management School five-month curriculum presents courses in two different areas of subject content. These areas are:

1. Basic Management. The basic management courses are designed to develop general managerial abilties for all naval officers. They provide the core of instruction in general management principles, criteria, techniques, and procedures for all categories of naval officers in billets in all types of naval activities. These courses are required and exemptive and are given mostly by the Applied and Financial Management Departments.

2. Special Management. These courses are designed specifically for management training of officers of various technical bureaus and offices in varied technical fields of administration. Such courses are given by all departments of the Management School.

The basic management phase of the curriculum comprises 216 contact and credit hours of education scheduled as 21 credit hours a week throughout two nine-week terms. It is considered that 21 contact hours a week is the optimum work program for the student. In certain cases the student is exempt from basic courses because of recent education or training. Should exemptions reduce his program below 21 hours, he is permtted to carry elective courses.

The special management phase is comprised of required and elective courses. The required courses vary depending upon officer designators. Curricula for various designators are established by the Bureau of Naval Personnel based upon the needs of the sponsoring technical bureaus.

GENERAL CURRICULUM (5 MONTH)

BASIC MANAGEMENT AREA

No.	Course Title	Department	Classification	Hours*
MN-301	Managerial Statistics	Financial	Exemptive	2
MN-302	Comptrollership	Financial	Exemptive	1
MN-303A&B	Managerial Accounting	Financial	Exemptive	2 - 2
MN-304A&B	Government Budgeting	Financial	Exemptive	2 - 2
MN-305	Auditing	Financial	Exemptive	1
MN-341	Principles of Management	Applied	Required	4
MN-342	Human Relations	Applied	Required	4
MN-343	Executive Control	Applied	Required	4

SPECIAL MANAGEMENT AREA

MN-306	Financial Management Seminar	Financial	Elective	1
MN-345	Industrial Relations	Applied	Required	5
MN-346A&B	Production Planning	Applied	Required	4 - 4
MN-347	Work Measurement	Applied	Required	4
MN-348	Work Simplification	Applied	Required	4
MN-351A&B	Materiel Management	Materiel	Required†	9 - 9
MN-352	Purchasing	Materiel	Elective	4
MN-353	Advanced Inventory Control	Materiel	Elective	4
MN-354	Contract Administration	Materiel	Required	5
MN-370	Transportation Management	Elective	Elective	4
MN-371	Materials-Handling	Elective	Elective	4
MN-471	Electronic Management Technique	Elective	Elective	3
MN-472	Operations Analysis for Management	Elective	Elective	3

* Hours indicated are for one semester of nine weeks except where indicated by A&B in course number, when they apply to both semesters.
† Required for all 3100 designators.

TABLE III

CURRICULA GIVEN WHOLLY BY THE MANAGEMENT SCHOOL

Curriculum	Group Designator	Length
Industrial Management	IE	8 weeks
Management	MG	5 months

CURRICULA CONDUCTED ENTIRELY AT OTHER INSTITUTIONS

Curriculum	Group Designator	Length	Institution	Liaison Official
Business Administration	ZKH	2 yrs.	Harvard	CO, NROTC Unit
Business Administration	ZKM	1 yr.	Michigan	CO, NROTC Unit
Business Administration	ZKS	2 yrs.	Stanford	CO, NROTC Unit
Comptrollership	ZS	1 yr.	George Washington	Prof. A. R. Johnson

NOTE: CO Indicates Commanding Officer.

MN-301 Managerial Statistics 2

To develop an understanding of statistics as a management control device. Emphasis is placed upon the use of statistics in Management. It introduces the student to the nature of statistics and fundamental techniques including sampling, central tendency, variation correlation, time series analysis, and statistical quality control with major emphasis on Navy applications. Considers the methods of presenting ideas and facts by statistical tables and their oral or written accompaniment.

MN-302 Comptrollership 1

Introduces the student to the general subject of comptrollership; examines the history and development of the office in industry and government; leads the student toward a formulation of a concept of comptrollership; examines the status of comptrollers and their functions primarily within the Navy but with comparison to Army and Air Force; investigates the functions of a comptroller and his relations to other echelons of command management; provides exposure to practicing comptrollers in industry and in the Navy.

MN-303A & B Managerial Accounting 2-2

Introduces the student to fundamental accounting concepts as recognized in private enterprise and to the concepts of governmental accounting as they are practiced in the Navy; examines record-keeping practices to meet the requirements imposed by superior requirements and management needs in the central office procedures, Bureau procedures and field activities of the Navy; encourages constructive criticism of principles and practices; examines practices of Navy Industrial Fund accounting; seeks to promote an understanding of Navy management use of accounting.

MN-304 A&B Government Budgeting 2-2

Is concerned with explanations of the relationship of Navy budgeting with the national economy and fiscal policy; the development of the budget process; the agencies influencing the process; the terminology of budgeting; concepts of performance budgets; estimating and justifying Navy budgets; the relationship of plans to budgets; budget cycles, review levels and methods; Congressional actions and influences; nature of appropriations, apportionment, allocations, administrative control of funds, and reporting; probable changes in base of appropriations and budgeting.

MN-305 Auditing 1

Examines the basic principles of internal control and internal auditing as comptrollership functions; defines the nature of the functions as recognized in business and government upon the background of their development; differentiates external and internal audits and relationship to inspections and investigations; determines agency conduct of the Navy Internal Audit program in general and as it relates to a specific activity; considers specific cases in auditing and audit reporting.

MN-341 Principles of Management 4

Presents the cycle of administration and other elements encountered in the solution of various naval organizational problems. Planning is discussed with emphasis on types of plans, limitations, and the analytical approach to method. Attention is directed to the principles of organization, including grouping functions, delegation, line, staff, and functional structure, and span of control. Case discussion is employed to focus attention and elicit student participation.

MN-342 Human Relations 4

Presents the broad areas of personnel management and public relations. Particular attention is devoted to problems of communication and understanding between individuals in both formal and informal organizational units. Emphasis is placed on gaining an understanding of the human aspects of administration as opposed to the more mechanical aspects of planning and organization. Emphasis is placed upon problems relative to the management of civil service personnel.

MN-343 Executive Control 4

Presents the aspects of control as an executive function and to integrate the courses in Principles of Management and Human Relations.

This course devotes attention to the various aspects of control as applied to efficient management. It also adopts the viewpoint of top management in formulating policy and in directing and controlling the efforts of an organization in the decision-making process. The course embraces and integrates the broader areas of basic management principles and human relations and relates the broad areas to the total executive function.

MN-306 Financial Management Seminar 1

The purpose of this course is to develop the student's habits and abilities to analyze and think about cases which reflect actual problems and working situations encountered in naval financial management.

This course directs attention to the elements of effective contract administration by illustrating the

MN-345 Industrial Relations 5

Provides a better understanding of the labor management areas so that from this broad background the Navy officer can survey labor problems and arrive at a more realistic solution. This course introduces the student to the nature of labor problems and studies the genisis of Trade Unionisf and Organized Labor. It discusses the Navy's Training and Career Development Program. The naval officer is acquainted with the problems of position classification, wage administration, employment regulations, and the Federal Appointment System. The Navy Incentives Award program is discussed and the officer student is appraised of the precepts, policies, and procedures of employee-management relations.

MN-346 A&B Production Planning 4-4

Acquaints the officer with the three basic elements of production, organizing, planning and control. The officer student is acquainted with the functions of production control, production planning and the techniques of production control. The process for analyzing manufacturing techniques and machine capacity are studied. Basic operating procedures for control, including orders, routing, scheduling and dispatching are discussed. The coordination process is discussed, emphasizing related activities of departments in order that they might bring about desired manufacturing results in terms of quality, quantity, time, and place.

MN-347 Work Measurement 4

Presents the officer student with the fundamentals of measurement and evaluation of productive performance.

This course includes information on tools of management, types of work measurement and governmental interest in problems of work measurement. The purpose of work measurement, the problem of uniform terminology, program development, and the process of collecting workload and man-hour data are discussed. The process of establishing standards, determining effectiveness, reporting and using work measurement data are studied. The student will also be acquainted with the application of measures and standards to forecasting, rate setting, and supervisory control.

MN-348 Work Simplification 4

Trains officers in procedures of analysis in order that they might use the facilities at their disposal more efficiently.

This course concerns itself with the processes of work simplification (value engineering) as it can be applied to Navy Management situations. It will concern itself with motion and time study in analyzing the methods, materials, tools and equipment used in the performance of a piece of work. This analysis would be carried on for the purpose of (1) finding the most economical way of doing this work; (2) standardizing the methods, materials, tools and equipment; (3) accurately determining the time required by a qualified person working at a normal pace to do the task; and (4) assisting in training the worker in the new method. In terms of value engineering, the course will devote itself primarily to principles of work simplification including (1) work distribution analysis; (2) motion analysis, and (3) layout analysis.

MN-351 A&B Materiel Management 9-9

Examines the nature of inventory management, and considers, current developments and difficulties in fleet support. Develops technical aspects of supply administration of interest to prospective senior officers.

Consumer and producer logistic considerations will be dealt with; however, major emphasis will be placed upon the Navy Supply System and its functioning in meeting the needs of the naval establishment. The organization of the Navy supply system will be set forth in relation to CNO, ONM, and DOD agencies, and to the other technical bureaus of the Navy Department. The following topics will be included: Determination of Requirements, Industrial Mobilization Planning, Purchasing, Transportation, Cataloging, Disposal, System Mobilization Planning, Supply Systems of Other Services, and Improvement of Inventory Management. Consideration will be given to the most advanced techniques being developed in supply management, and to major problems being encountered in such areas as purchasing, storage, materials handling, preservation and packaging, transportation, subsistence, and clothing.

MN-352 Purchasing 4

Develops a thorough understanding of the basic principles upon which sound procurement policy and administration is based. The course is developed to indicate its relationship to sound inventory control practices and various procurement methods employed by the Navy.

MN-353 Advanced Inventory Control 4

Develops an advanced understanding of Inventory Control methods. This course will consider advanced inventory control methods in respect to national defense, budgeting, and logistical and technological factors.

MN-354 Contract Administration 5

Presents the aspects of good contract administration through supervised analysis of case studies.

close cooperation required between Bureau and field personnel. It discusses the factors affecting the above relationship, the signficance of various types, the process of selecting and evaluating contractors, and the process of evaluating and insuring the progress of the contractor. Pricing, regulations for government assistance, approval, amending or changing the contract, and terminations and endings of contracts are discussed.

MN-370 Transportation Management 4

To develop an understanding of the management of the four fields of transportation, air, highway, rail and water.

Primary emphasis will be placed on the economic use of transportation in respect to inventory and purchasing. The course will include study regarding both commercial and governmental transportation especially in regard to logistic considerations.

MN-371 Materials Handling 4

This course is designed to provide the officer student with an understanding of the function and organization of materials handling.

This course will concern itself with developing an understanding of the fundamental relationships which affect the movement, storage and handling of materials. It will provide the officer with a knowledge of the techniques and methods by which these relationships may be ascertained. An understanding of the various types of equipment, movement and the equipment necessary to accomplish such movement. It will provide the opportunity to determine relationship of material handling to management, labor, and the public, thereby enhancing the officer's knowledge of the operational and managerial problems involved in materials handling.

A General Line School class discussing and planning a mock operation, giving the students an insight into the organization of a task force and the procedure by which an operation order is developed.

Orientation class in combat information center mock-up.

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